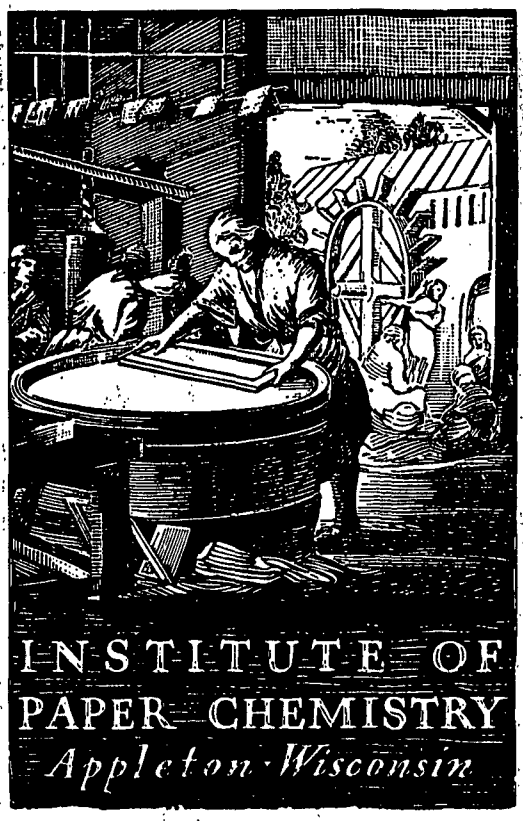

AN INVESTIGATION OF LINTING AND FLUFFING OF OFFSET NEWSPRINT

Project 2949

Report Five

A Progress Report

to

MEMBERS OF GROUP PROJECT 2949

May 16, 1975

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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Bowater Incorporated

International Paper Company

Southwest Forest Industries, Inc.

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THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

AN INVESTIGATION OF LINTING AND FLUFFING OF OFFSET NEWSPRINT

SUMMARY

A laboratory linting test, employing a polyisobutylene test oil as an ink simulant, with an IGT printability tester has been shown to correlate well with small offset press linting tests. The amount of lint collected from 25 IGT test specimens, however, was so small that very precise weighing was required for gravimetric determination. The time and skill needed for such determinations will limit the use of the method. However, the amount of lint collected from only 5 IGT test specimens, when accumulated on black filter paper, could be reproducibly visually ranked to provide a relative linting tendency which correlated with both the gravimetric determination of IGT lint and with the results of the small press linting tests. IGT linting tendency by the gravimetric procedure correlated better when the sample set was restricted to either northern or southern newsprints than when both were included in the same set.

Visual ranking of the amount of fuzz which is visible on the paper surface when illuminated at grazing angle by a Landsco Light (1) showed some correlation with press linting behavior but agreement between observers was poor, particularly when a wide variety of newsprints were included. Results were better when all papers were of similar composition. It seems unlikely that this method will be reliable for predicting relative linting tendency of dissimilar papers. However, in view of its speed and simplicity, use for production control purposes should be further investigated.

INTRODUCTION

In previous work under this project a quantitative test for the linting tendency of newsprint, employing a small web-fed offset press, was developed. This test method provides a gravimetric determination of the quantity of lint accumulated on the blanket and on the inking rolls and isolates lint particles under conditions which permit use of fiber analysis techniques. Subsequent study of the mechanism of lint accumulation and transport has indicated that water greatly affects the ability of the blanket to retain lint which has already been picked up, but does not seem to have an important affect upon the initial lint pick up from the paper. If this is true, a much simpler device employing an ink simulant but no water should be adequate for determining the relative linting tendency of papers. A test using polyisobutylene oil on the IGT printability tester was devised. Lint was collected from the printing disk after each impression against the paper. The amount of lint accumulated in this test correlated well with the amount found by the small press linting test. The present work was undertaken to determine the reliability of this laboratory test over a greater number of newsprints.

In addition, the claim has been made that visual ranking of newsprint surfaces by the amount of fuzz which is evident under grazing illumination by a Landsco Light can be used to predict linting tendency. The number of newsprints which had been tested by the small press linting test for the present study provided materials for evaluating the utility of such visual ranking.

EXPERIMENTAL METHODS

DESCRIPTION OF NEWSPRINTS

Ten different newsprints were submitted by project member companies. For purposes of reporting the results, a series of two letter codes AB, CD,...,ST have been assigned to these papers. Each company is being informed of the codes which identify the papers they submitted. In all cases the first letter of the pair is used to identify the inside surface of the web and the second letter to identify the outside surface (i.e., the surface exposed on the outside of the roll). Among the fourdrinier sheets all but one of the papers was wound with wire side out. Two of the papers are believed to be from twin wire machines.

Fiber analysis of the newsprint is shown in Appendix I.

LINTING TESTS WITH THE APOLLO PRESS

The press tests were conducted by the method described in previous reports using the halftone and solid plate image of Report Two. When papers were printed on the outside surface the added moisture accentuated the curl already present in the roll and jammed the delivery. Consequently, in all tests made on this side of the web the paper was passed around a rolling decurl bar (1/2-inch diameter free turning roll) to compensate for this effect. The decurl bar was not needed, and was not used, when printing on the inside surface of the web.

Lint was isolated from the blanket with wax as described in Report One. Lint was also isolated from the inking rollers (but not from the ink fountain or plate) as previously described. Photographic contact prints were prepared from

the lint bearing wax to record the distribution of lint on the blanket. A few of these prints which appear to be pertinent to interpretation of results are included in Appendix II.

No subjective ranking of print quality was undertaken. However, end-of-run prints are included in Appendix IV. These prints are identified by both run number and paper surface letter code.

LINTING TESTS WITH THE IGT PRINTABILITY TESTER

A gravimetric test of linting tendency which employs the IGT printability tester was described in Report Four. Sample specimens were printed at constant speed (17.8 cm/sec) with polyisobutylene test oil using the 2-cm steel printing disk and a rubber blanket-covered impression segment. After printing each specimen the residual oil containing lint was removed from the disk with a razor blade and the lint from 25 specimens (1000 cm^2 of sample) was isolated and weighed. The same general method was used in the present work but several modifications in procedure were tried and accepted or rejected before the actual linting tests were performed.

It seemed wise to improve the simulation of press conditions by use of a blanket-covered printing disk instead of the steel disk. The nip would then be similar to that of a blanket-to-blanket offset press. It had been anticipated that the better conformation of the rubber printing surface to the paper would increase the amount of lint collected but, in fact, the amount decreased. It was then observed that when the steel disk was used the specimen followed the printing disk beyond the nip, as is shown in Fig. 1. This can be explained by the local increase in surface speed of the rubber as it is forced through the restricted nip zone. As a consequence, the paper specimen and the printing

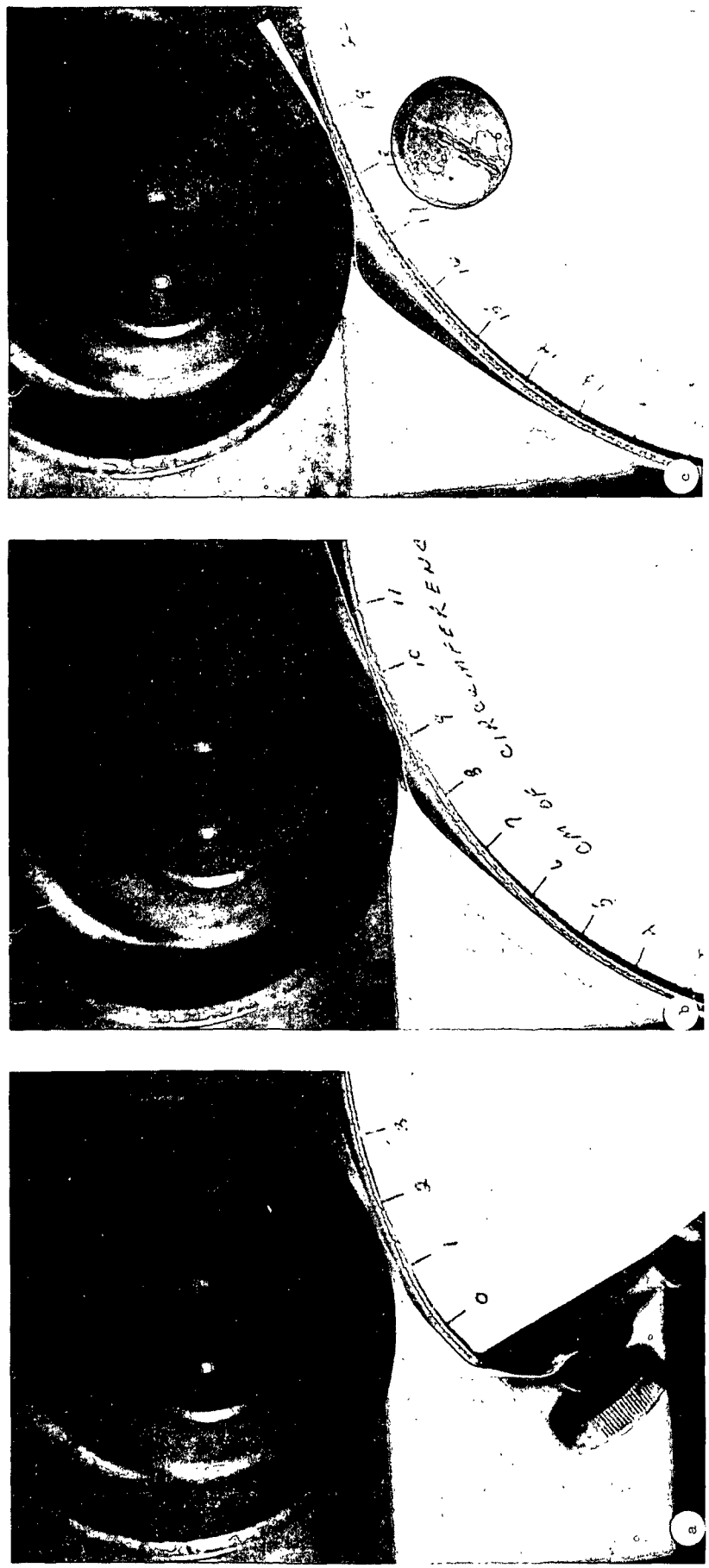

Figure 1. IGT Printability Tester with Steel Printing Disk, Offset Blanket on Impression Segment and Specimen Held in Clamp at the Leading End but Trailing End not Restricted, (a) at Start, (b) Near Center, and (c) Near End of Print

disk are driven at a higher velocity than the nominal velocity of the impression sector. The effect on the inking disk is compensated if it too has a deformable rubber surface. To determine whether the greater amount of lint removed by the steel disk was due to the sharp bend in the paper specimen as it was pulled from the disk, another series of tests was conducted in which the trailing end of the test specimen was taped to the impression segment. This effectively prevented the specimen from following the printing disk beyond the impression zone as can be seen in Fig. 2. However, even when the sharp bending of the specimen was prevented by this means, the steel disk continued to collect more lint than the rubber covered disk. The reason for this difference has not been established. However, in view of the greater amount of lint removed, the easier recovery of residual oil and the stable surface properties of the steel disk, it was selected for continued use in the testing program and use of the rubber-covered disk was abandoned. However, the practice of taping the trailing end of the test specimen to the impression segment was adopted because it was felt that a peeling angle which changes along the length of the specimen is undesirable.

It was desired to test all ten papers on both sides under the same conditions. Therefore, a number of preliminary tests were made to determine the viscosity of polyisobutylene which could be used without picking any of the papers. A 1059 poise oil was selected as being suitable.

VISUAL RANKING BY SURFACE FUZZ

The claim has been made that linting tendency can be predicted by visual examination using the oblique illumination of a Landsco Light (1). This light source utilizes a glass plate with cylindrical lenticular elements to spread the light uniformly over the surface of the paper while restricting

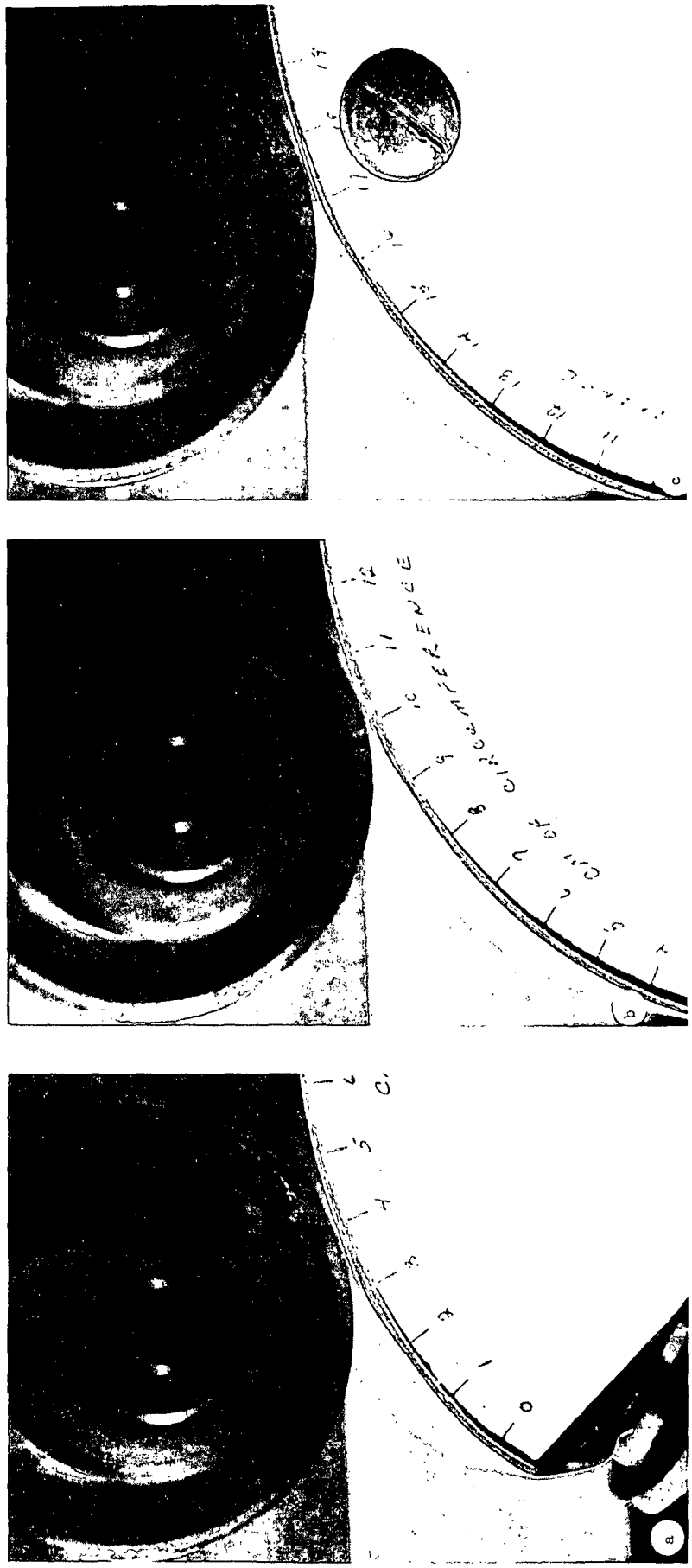

Figure 2. IGT Printability Tester with Steel Printing Disk, Offset Blanket on Impression Segment and Specimen Held by Clamp at Leading End and Tape at Trailing End, (a) at Start, (b) Near Center, and (c) Near End of Print

it to a narrow range of grazing incident angles. In the absence of other light, surface irregularities became particularly evident. In addition, fuzz or fine fibers which extend beyond the consolidated surface, which are not normally visible, scatter enough light to be detected. If the presence of such fuzz correlates well with linting tendency, examination in this way could prove to be a useful production control test method. Therefore, it was decided to determine how well visual ranking experiments using this light source would correlate with small press linting studies.

The recommendations of the manufacturer regarding the use of the light source were followed. A vacuum plate was used to hold the paper samples flat and minimize shadowing due to wrinkles and cockle. Sample photographs of linty sheets supplied by the light manufacturer were used to instruct the judges regarding the features to observe. One of the judges, in addition to ranking the undisturbed surfaces, also used controlled brushing techniques to determine whether lint raised by mild mechanical treatment might correlate better with actual press linting tests.

DISCUSSION OF EXPERIMENTAL RESULTS

LINTING TESTS WITH THE APOLLO PRESS

The results of Apollo press lint tests on both sides of the ten newsprints are summarized in Table I. Tests were conducted in the random order which is indicated by the press run numbers which are included in the table. Two runs were made on each side of each paper. In all but two cases these duplicate individual determinations deviated by less than 6% from their average. These were considered to be satisfactory checks. The two paper surfaces depositing the greatest amount of lint, surfaces Q and S, showed deviations from average of 16.8 to 9.4%, respectively. The tendency of heavy deposits of blanket lint to flake off and leave aggregates of lint in the stack of printed product has previously been observed with papers which are heavy linters. Under these conditions replicate determinations frequently do not check closely. The contact prints of blanket lint (Runs 21 and 38 for Q and Runs 18 and 31 for S), which are included in Appendix II show evidence of such loss of blanket lint. Two other prints of blanket lint (Runs 1 and 37 on paper Surface A) are included to show the more normal distribution of lint. In this case the duplicate determinations checked closely.

It should be noted that Surface Q provided more than 9 times as much lint as Surface P. When it is recalled that the heavy linters probably supplied a greater amount of lint than was retained by the press and found gravimetrically, it is clear that these 20 paper surfaces possess a very wide range of linting tendency.

The two-sidedness of linting tendency is indicated by the total lint ratio (greater linting side/lesser linting side) which is included in Table I.

TABLE I

RESULTS OF PRESS AND IGT GRAVIMETRIC LINTING DETERMINATIONS

Press Run	Paper Code	Side[a] Code	Side	Blanket Lint, g	Ink Lint, g	Total Lint, g	Average Total Lint, g	Total[c] Lint Ratio	IGT Lint, mg	Average IGT Lint, mg
1	AB	A	F	0.1639	0.0829	0.2468			1.1	
37	AB	A	F	0.1732	0.0696	0.2428	0.2448		0.7	0.9
20	AB	B	W	0.0708	0.0288	0.0996			0.3	
14	AB	B	W	0.0790	0.0165	0.0955	0.0976	2.5	0.0	0.2
30	CD	C	F	0.1411	0.0325	0.1736			0.7	
32	CD	C	F	0.1449	0.0491	0.1940	0.1838		1.8	1.3
10	CD	D	W	0.0635	0.0187	0.0822			0.4	
29	CD	D	W	0.0684	0.0140	0.0824	0.0823	2.3	0.6	0.5
34	EF	E	F	0.2523	0.1392	0.3915			1.1	
23	EF	E	F	0.2884	0.0900	0.3784	0.3850		1.4	1.3
12	EF	F	W	0.1213	0.0445	0.1658			0.4	
5	EF	F	W	0.1328	0.0347	0.1675	0.1667	2.3	0.3	0.4
17	GH	G	W	0.0891	0.0296	0.1187			0.9	
39	GH	G	W	0.0969	0.0342	0.1311	0.1249		1.6	1.3
13	GH	H	F	0.1616	0.0715	0.2331			1.5	
16	GH	H	F	0.1699	0.0530	0.2229	0.2280	1.8	2.5	2.0
7	IJ	I	F	0.1558	0.1242	0.2800			3.0	
33	IJ	I	F	0.1771	0.0831	0.2602	0.2701		3.4	3.2
6	IJ	J	W	0.0717	0.0390	0.1107			0.7	
26	IJ	J	W	0.0691	0.0414	0.1105	0.1106	2.4	0.5	0.6
11	KL	K	F	0.1893	0.1472	0.3365			1.2	
36	KL	K	F	0.1926	0.1439	0.3365	0.3365		1.4	1.3
2	KL	L	W	0.1070	0.0596	0.1666			0.7	
28	KL	L	W	0.1359	0.0448	0.1807	0.1737	1.9	0.3	0.5
25	MN	M	[b]	0.1222	0.0440	0.1662			0.7	
40	MN	M		0.1431	0.0345	0.1776	0.1719		0.7	0.7
19	MN	N		0.1030	0.0388	0.1418			0.0	
27	MN	N		0.1037	0.0332	0.1369	0.1394	1.2	0.0	0.0
8	OP	O	[b]	0.0760	0.0323	0.1083			0.8	
35	OP	O		0.0793	0.0350	0.1143	0.1113		0.9	0.9
3	OP	P		0.0668	0.0137	0.0805			0.7	
22	OP	P		0.0689	0.0127	0.0816	0.0811	1.4	0.7	0.7
21	QR	Q	F	0.6788	0.1836	0.8624			5.7	
38	QR	Q	F	0.4916	0.1226	0.6142	0.7383		7.3	6.5
9	QR	R	W	0.0683	0.0174	0.0857			0.9	
15	QR	R	W	0.0726	0.0126	0.0852	0.0855	8.6	1.4	1.2
18	ST	S	F	0.3285	0.2032	0.5317			1.3	
31	ST	S	F	0.4256	0.2170	0.6426	0.5872		2.4	1.9
4	ST	T	W	0.2073	0.0413	0.2486			1.5	
24	ST	T	W	0.1882	0.0808	0.2690	0.2588	2.3	1.1	1.3

[a] The first letter of the paper code is used to identify the side of the paper wound inside on the roll. The second letter identifies the outside surface.

[b] Believed to be from a twin-wire machine.

[c] Ratio of lint amounts from the two sides of the paper.

All the papers except GH provided more lint from the inside surface. Examination of GH showed that it was the only fourdrinier sheet wound with the felt side out. These ratios varied from 1.8 to 8.6 for fourdrinier sheets and values of 1.2 and 1.4 were found for the two papers which are believed to come from twin wire machines.

GRAVIMETRIC LINTING TESTS WITH THE IGT PRINTABILITY TESTER

In the IGT linting tests the viscosity of the picking oil was dictated by the papers of greatest linting tendency because of the desire to test the full range of papers with a single test oil which would not pick any of the surfaces. As a result, the amount of lint collected from the better papers was so small that it could not be determined with the precision which was desired. In commercial testing it would be preferable to choose an oil suited to the average of the papers to be compared. Duplicate and average values for lint collected from 25 IGT test strips are included in Table I. Figure 3 is a plot of the average IGT lint against the average total press lint. The regression line, with correlation coefficient of 0.79, indicates a significant relationship. On Fig. 3 the points for all the northern newsprints fall above the regression line and only two of the points for southern newsprints fall above (but near) this line. This suggests that the data for these two groups of papers should be treated separately.

Of the six southern papers, five have similar composition, as indicated by the fiber analysis (Appendix I). The sixth (Paper EF) contains a considerable quantity of high-yield hardwood not found in the others. IGT lint data for the five papers of similar composition were plotted against corresponding press lint data. This plot is shown as Fig. 4. The correlation coefficient for this group of data is 0.84. The data points for paper Surfaces E and F, which were not used in calculating the regression line or correlation coefficient, have been added

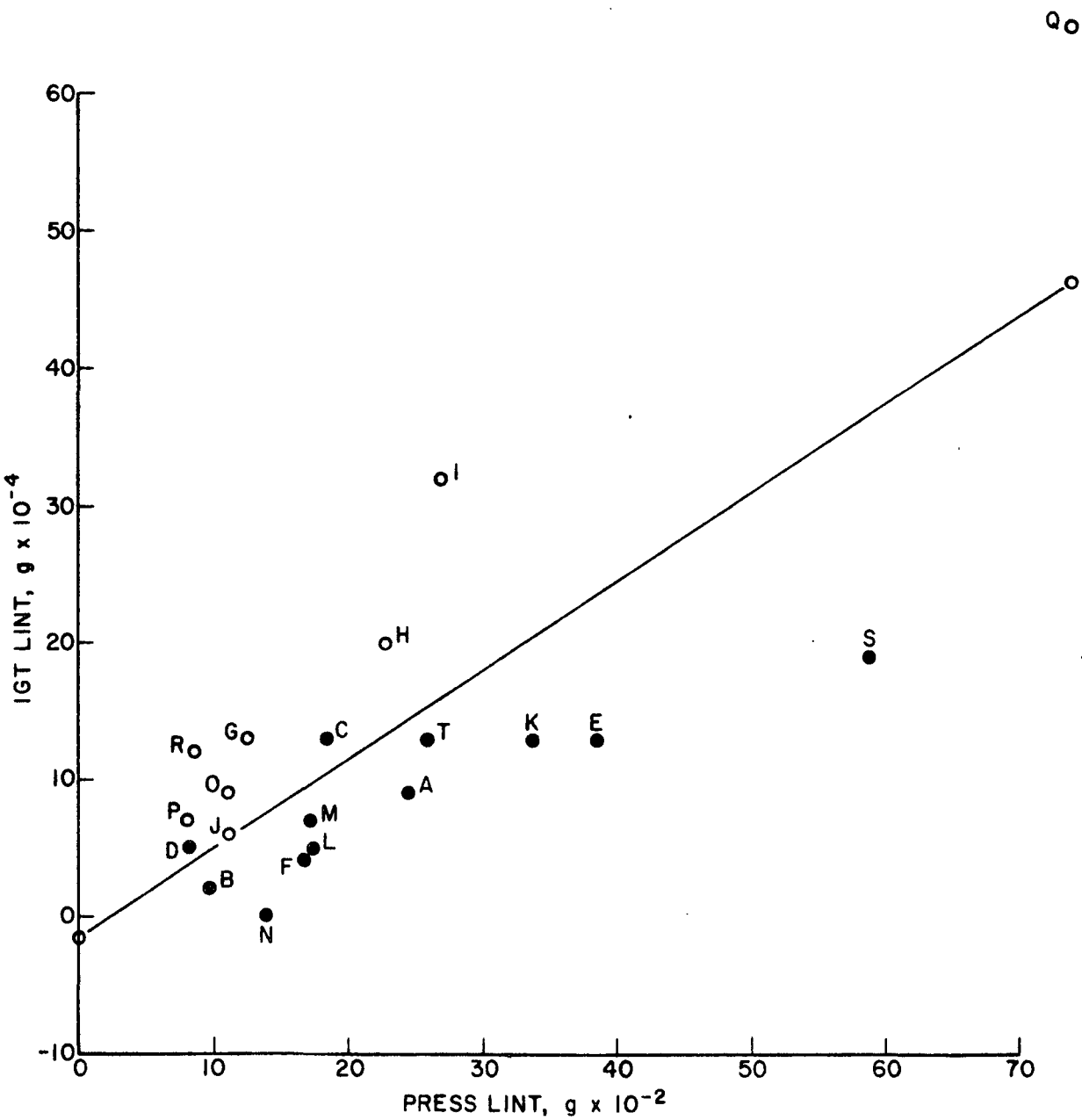

Figure 3. Plot of IGT Lint Versus Press Lint for all 20 Paper Surfaces. Letters Identify the Paper Surfaces, Closed Data Points are Southern Newsprints

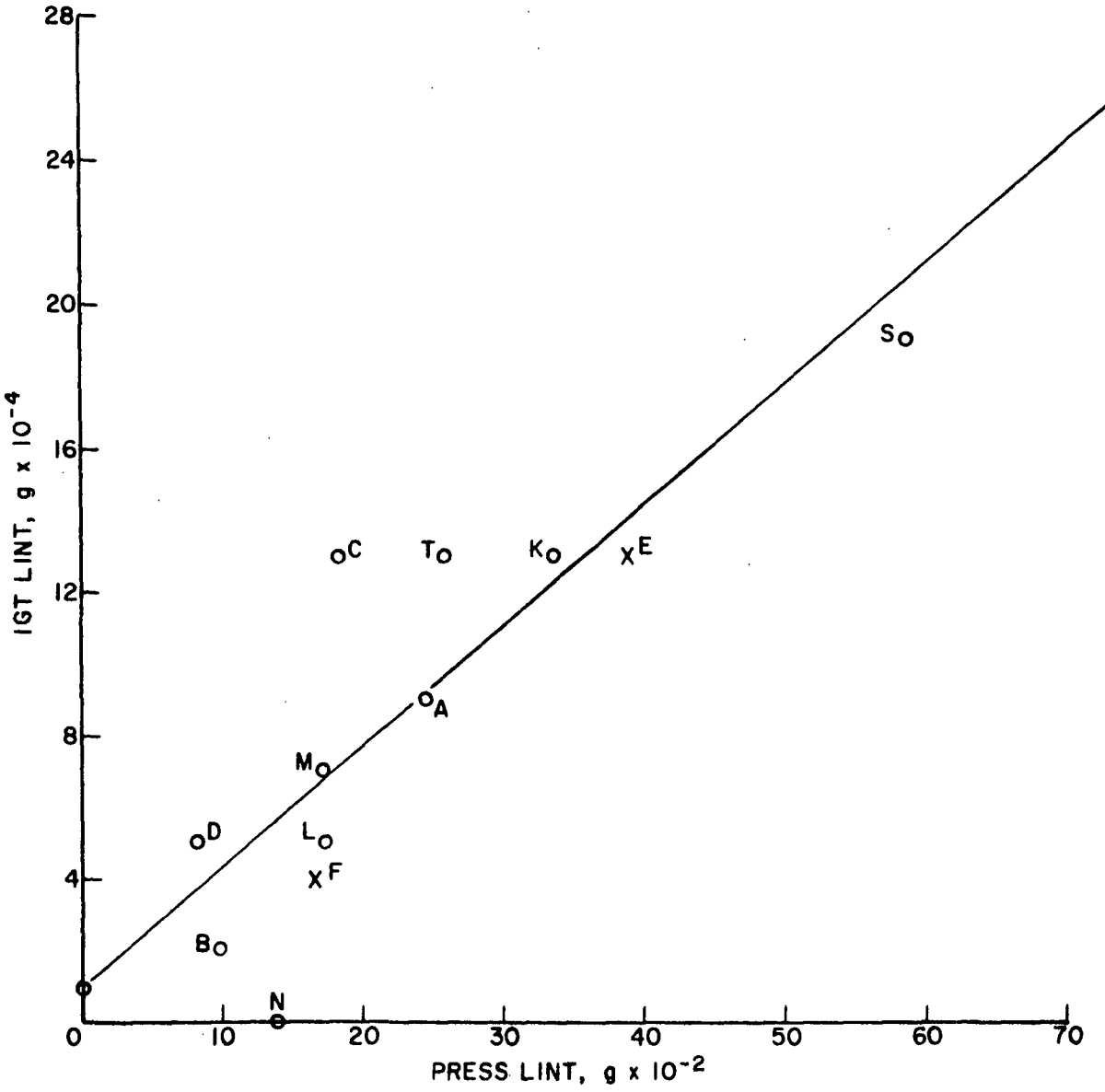

Figure 4. Plot of IGT Lint Versus Press Lint for Southern Newsprints. Letters Identify the Paper Surfaces. Data Points E and F Were not Used in Calculating the Regression Line Because of a Somewhat Different Fiber Composition

to the plot. Their proximity to the regression line indicates that they could have been included without significantly affecting the result.

A corresponding plot of the IGT lint and press lint for the northern newsprints is shown as Fig. 5. These papers do have differences in fiber composition which are noted in Appendix I. However, the correlation coefficient is 0.98. This high correlation is remarkable when the problem of weighing the small amounts of IGT lint is considered.

It is clear that use of the IGT test provides a useful measure of press linting tendency (as judged by the Apollo press) but that the procedure as practiced in these experiments favors southern papers over northern papers. Therefore, the procedure is most reliable for estimating linting differences between similar papers.

VISUAL RANKING OF LINT USING THE IGT PRINTABILITY TESTER

The lint test requires printing of 25 test specimens to obtain a sufficient quantity of lint for gravimetric determination. Even then the weight may be too small to be determined with the desired precision. Therefore, the visual comparison method described in Report Four was used on the ten surfaces of the 5 southern newsprints of similar composition. The combined lint from only five test strips was filtered out on a filter paper which had been blackened with Chlorazol Black E dye. The filter papers were then ranked in the order of apparent increasing amount of lint as judged visually. The filters containing lint were also photographed and these photographs were also ranked in a similar manner. These photographs are included in Appendix III. The rank obtained from lint-bearing filters is considered to be the more reliable. The photographs cover smaller areas which may not be fully representative of the entire filter area.

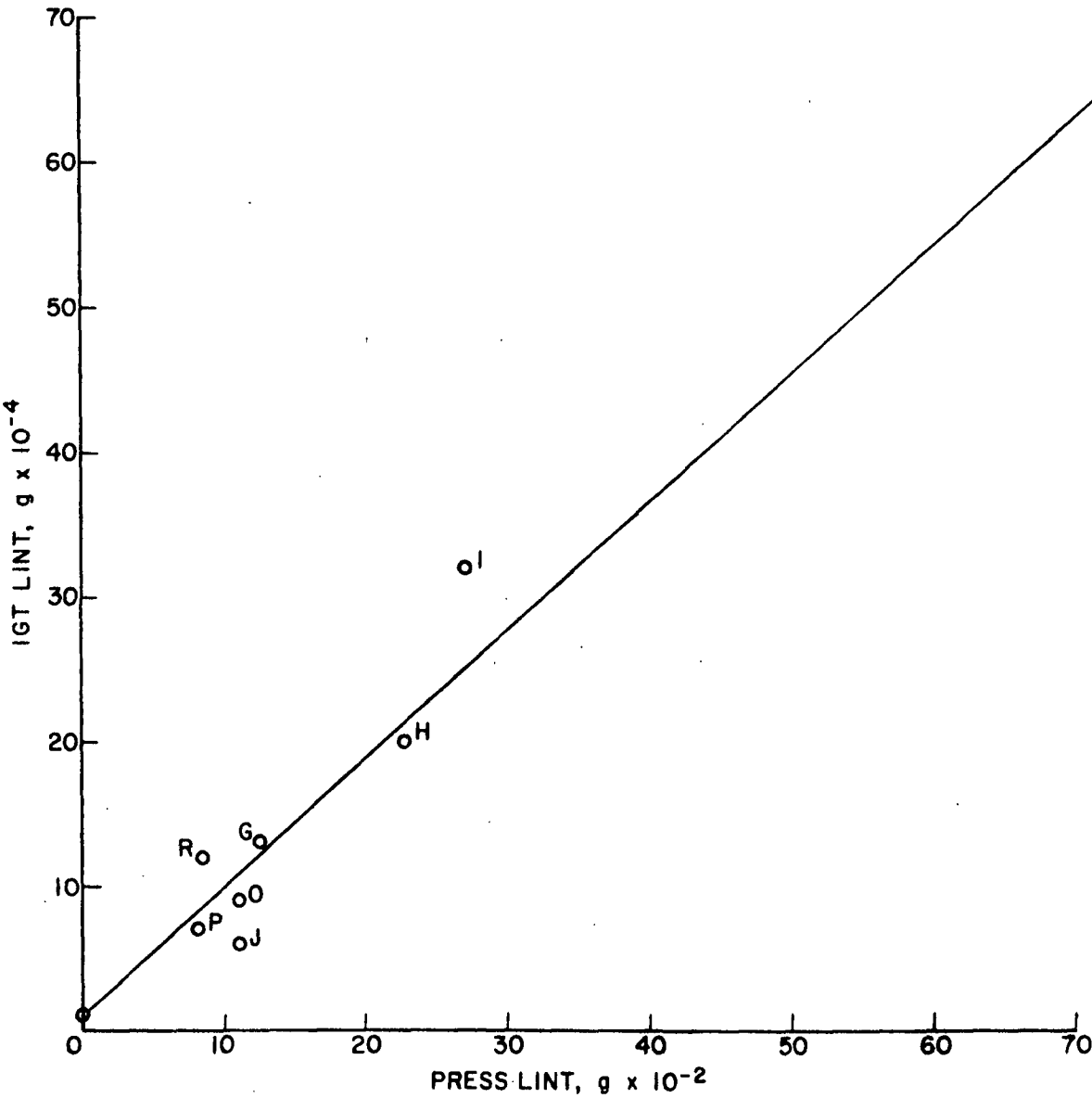

Figure 5. Plot of IGT Lint Versus Press Lint for Northern Newsprints. Letters Identify the Paper Surfaces

The rank orders are shown in Table II. For comparative purposes the weights of lint collected by both press and gravimetric IGT tests were converted to a rank order and these are also included in Table II for comparison. Paper surfaces providing average total press lint which differed by 1% or less were considered equal in rank.

VISUAL RANKING BY SURFACE FUZZ

Table II also contains the results of the visual ranking of the 20 paper surfaces using the Landsco Light. Inasmuch as it was previously found that improved agreement of IGT data with press results was achieved when the southern and northern paper data were separated, these results were also separated in analogous fashion. It is evident that the assigned ranks depart considerably from the press rank order and that there are wide differences between the orders preferred by the two judges (BJ and RT). Experiments in which one of the judges brushed the surfaces to raise the linting fibers prior to ranking, changed the order of ranking but did not improve agreement with press results. These latter results are not shown on Table II.

CORRELATION BETWEEN LINTING TESTS

The Apollo press test is the only one of the linting tests which has been used in this study which endeavors to, as far as is feasible, simulate printing conditions. In the absence of established correlation of the Apollo press test to experience with commercial presses, which is beyond the scope of this project, the Apollo press results must be used as the most reliable measure to which other methods are compared. The press test and the gravimetric IGT test both provide numerical values from which regression lines and correlation coefficients (r) can be calculated. In contrast, the visual IGT test and the visual ranking with

TABLE II

LINTING TENDENCY RANK[a]

Paper Surface Code	Press Test Rank			IGT Gravimetric Rank			IGT Visual Rank			Visual Rank with Landsco Light					
							10 Southern Surfaces[c]			20 Surfaces		10 Southern Surfaces		8 Northern Surfaces	
	20 Surfaces	10 Southern Surfaces[c]	8 Northern Surfaces	20 Surfaces	10 Southern Surfaces[c]	8 Northern Surfaces	RT[d] (Lint)	RL[d] (Lint)	RL[d] (Photos)	BJ[d]	RT[d]	BJ[d]	RT[d]	BJ[d]	RT[d]
Q	20		8	20		8				11	16			5	6
S	19	10		17	10		10	10	10	20	20	10	10		
E	18			14						7	12				
K	17	9		14	8		8	8	8	19	13	9	6		
I	16		7	19		7				17	10			8	5
T	15	8		14	8		7	7	7	18	18	8	9		
A	14	7		9.5	6		6	6	5	5	15	2	8		
H	13		6	18		6				13	1			6	1
C	12	6		14	8		9	9	9	14	8	6	4		
L	10.5[b]	4.5		4.5	3.5		4	4	3	15	7	7	3		
M	10.5[b]	4.5		7.5	5		3	3	4	10	14	4	7		
F	9			3						4	2				
N	8	3		1	1		1.5	2	1	8	5	3	2		
G	7		5	14		5				9	6			4	3
O	5.5[b]		3.5	9.5		3				3	19			2	8
J	5.5[b]		3.5	6		1				16	9			7	4
B	4	2		2	2		1.5	1	2	2	11	1	5		
R	3		2	11		4				6	4			3	2
D	2	1		4.5	3.5		5	5	6	12	3	5	1		
P	1		1	7.5		2				1	17			1	7

[a] With rank number increasing with increasing linting tendency.

[b] When average total lint differed by 1% or less the surfaces were considered to be of equal rank.

[c] Paper EF not included because of differing composition.

[d] Judges for visual ranking: BJ, Betty John; RT, Russell Tyler; RL, Robert Leekley.

grazing illumination, as used in this study, provide only a rank order without indicating the degree of difference between samples of adjacent rank. This limitation requires that the Spearman correlation coefficient of ranks, r_s, rather than the correlation coefficient, r, be used for comparison of test methods.

Table III contains the Spearman values, r_s, which are a measure of the agreement of the other test methods with the press test. Where appropriate, correlation coefficients, r, are also included. The gravimetric IGT method provides r and r_s values for the 20 paper surfaces which are significant at the 1% level, but the correlation improves when the subsets of 10 similar southern paper surfaces and 8 northern paper surfaces are considered separately. Visual ranking of IGT lint, which was done only on the 10 southern paper surfaces of similar composition, provided r_s values with press rank which are significant at the 1% level. When ranked from photographs r_s is significant at the 5% level. The high r_s values for visual IGT lint ranking with IGT gravimetric ranking, provides no incentive for conducting the more laborious gravimetric tests. The Landsco Light correlations are generally poorer.

On the basis of this comparison of linting tests, it appears that the IGT procedure with a visual ranking of amount of lint provides a reasonably quick and reliable indication of linting tendency. The extra time and care needed to determine the quantity gravimetrically does not seem to be justified. The amount of surface fuzz which is visible under illumination with the Landsco light is related to linting, but serious discrepancies arise in comparing dissimilar newsprints. However, those needing an inspection method for production control purposes should further investigate this possibility.

TABLE III

CORRELATION OF TEST RESULTS

Test	With Press Test		With IGT Grav. Test	
	r [a]	r_s [b]	r [a]	r_s [b]
IGT gravimetric test				
20 paper surfaces	0.79[c]	0.69[c]		
10 surfaces of southern papers	0.84[c]	0.89[c]		
8 surfaces of northern papers	0.98[c]	0.86[c]		
IGT test with visual ranking				
10 surfaces of southern papers				
By RT on actual lint		0.80[c]		0.95[c]
By RL on actual lint		0.80[c]		0.94[c]
By RL on photographs of lint		0.72[d]		0.94[c]
Landsco Light visual rankings				
By BJ				
20 paper surfaces		0.56[c]		
10 surfaces of southern papers		0.71[d]		
8 surfaces of northern papers		0.68		
By RT				
20 paper surfaces		0.35		
10 surfaces of southern papers		0.79[c]		
8 surfaces of northern papers		-0.26		

[a] r = correlation coefficient.

[b] r_s = Spearman correlation coefficient of ranks.

[c] Correlation significant at 1% level.

[d] Correlation significant at 5% level.

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APPENDIX I

FIBER ANALYSIS OF COOPERATORS' PAPERS

Paper AB

52% Softwood groundwood, medium grade. Species: southern and/or jack pine identification group.
46% Softwood lightly bleached kraft. Species: southern and/or jack pine identification group — prefer southern pine.
2% Hardwood kraft. Species: beech and red gum.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. The groundwood exhibits numerous fines in the form of debris. Some fibrillation fines are present. Numerous partial fibers of short to medium length are present. A very few shives two-three fibers thick are observed.

Paper CD

55% Softwood groundwood, medium grade. Species: southern and/or jack pine identification group.
43% Softwood lightly bleached kraft. Species: southern and/or jack pine identification group — prefer southern pine.
2% Hardwood kraft. Species: maple and/or basswood, oak and/or chestnut, and evergreen magnolia.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. Numerous groundwood fines are observed which include both debris and fibrillation fines. Numerous partial fibers of medium length are observed. A very few shives up to five fibers thick are observed.

Paper EF

40% Softwood groundwood, medium grade. Species: southern and/or jack pine identification group.
25% Hardwood high yield pulp — probably cold soda, unbleached. Species: oak and/or chestnut, maple and/or basswood, gum, populus group — prefer populus genera and possibly others.
35% Softwood lightly bleached kraft. Species: southern and/or jack pine identification group — prefer southern pine.
Trace hardwood kraft. Species: maple and/or basswood.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. The groundwood exhibits numerous debris and fibrillation fines. Numerous partial fibers of short to medium length are observed. A very few shives usually two-three fibers thick are observed.

Paper GH

70% Softwood groundwood, coarse grade. Species: spruce and/or hemlock identification group.
30% Softwood unbleached sulfite, medium cook. Principal species: spruce and/or hemlock identification group. Some white pine identification group.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. Numerous groundwood fines are observed including debris, ray cells, and fibrillation fines. Numerous long partial fibers are seen. Some shives up to five fibers thick are observed. Long ray crossings are usually associated with the shives.

Paper IJ

74% Softwood groundwood, coarse grade. Species: spruce and/or hemlock identification group.
26% Softwood unbleached sulfite, very raw cook. Species: spruce and/or hemlock identification group.
Trace Hardwood groundwood. Probable species populus group.
Trace Hardwood unbleached sulfite. Insufficient for species identification.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. Numerous fines in the form of ray cells and fibrillation fines are exhibited by the groundwood. Some debris fines are also observed. Numerous partial fibers of medium to long length are observed. A few shives two-three fibers thick are observed. These shives usually exhibit extensive ray crossings.

Paper KL

52% Softwood groundwood, medium grade. Species: southern and/or jack pine identification group.
45% Softwood lightly bleached kraft. Species: southern and/or jack pine identification group — prefer southern pine.
3% Hardwood kraft. Species: beech, gum, and oak and/or chestnut.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. Numerous groundwood debris fines are observed. Numerous partial fibers of medium length are observed. A few shives up to five fibers thick are exhibited.

Paper MN

55% Softwood groundwood, coarse grade. Species: southern and/or jack pine identification group.
42% Softwood lightly bleached kraft. Species: southern and/or jack pine identification group — prefer southern pine.
3% Hardwood kraft. Species: red gum, oak and/or chestnut, and maple and/or basswood.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. Numerous groundwood fines are exhibited principally in the form of debris but some fibrillation fines are also present. Numerous partial fibers of medium to long length are observed. A very few shives are exhibited which are generally short; they may be up to five fibers thick.

Paper OP

82% Softwood groundwood, coarse grade. Principal species: spruce and/or hemlock identification group. Trace of southern and/or jack pine identification group.
18% Softwood lightly bleached kraft. Principal species: spruce and/or hemlock identification group. Trace of southern and/or jack pine identification group—prefer jack pine.
Trace Hardwood kraft. Species: populus group, prefer populus genera.
Trace Hardwood groundwood. Insufficient for species identification.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. The groundwood exhibits numerous fines. They are mostly ray cell and fibrillation fines; but some debris is observed. Numerous partial fibers are observed which are quite long. Some shives are observed which may be up to eight fibers thick but are generally two-three fibers thick. Extensive ray crossings are usually associated with the shives.

Paper QR

82% Softwood groundwood, coarse grade. Principal species: spruce and/or hemlock identification group. Traces of southern and/or jack pine and white pine identification groups.
18% Softwood lightly bleached kraft. Principal species: spruce and/or hemlock identification group. Trace of southern and/or jack pine identification group — prefer jack pine.
Trace Hardwood kraft. Species: Populus group — prefer populus genera.
Trace Hardwood groundwood. Species: Populus group — prefer populus genera.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. Numerous groundwood ray cell fines are exhibited. Some fibrillation and debris fines are also exhibited. Numerous partial fibers are observed which tend to be quite long. A few coarse shives up to eight fibers thick are observed.

Paper ST

50% Softwood groundwood, coarse grade. Principal species: southern and/or jack pine identification group. Trace of Douglas-fir.
50% Softwood lightly bleached kraft. Principal species: southern and/or jack pine identification group — prefer southern pine. Traces of spruce and/or hemlock identification group — prefer west coast wood, cedar, Douglas-fir, and the white pine identification group.

Remarks: The chemical furnish exhibits little or no cutting or fibrillation. Numerous groundwood fines in the form of debris are observed. Some fibrillation fines are also present. Numerous quite long and coarse partial fibers are observed. Some shives two-three fibers thick are observed. A very few long, very coarse shives five-six fibers thick are also present.

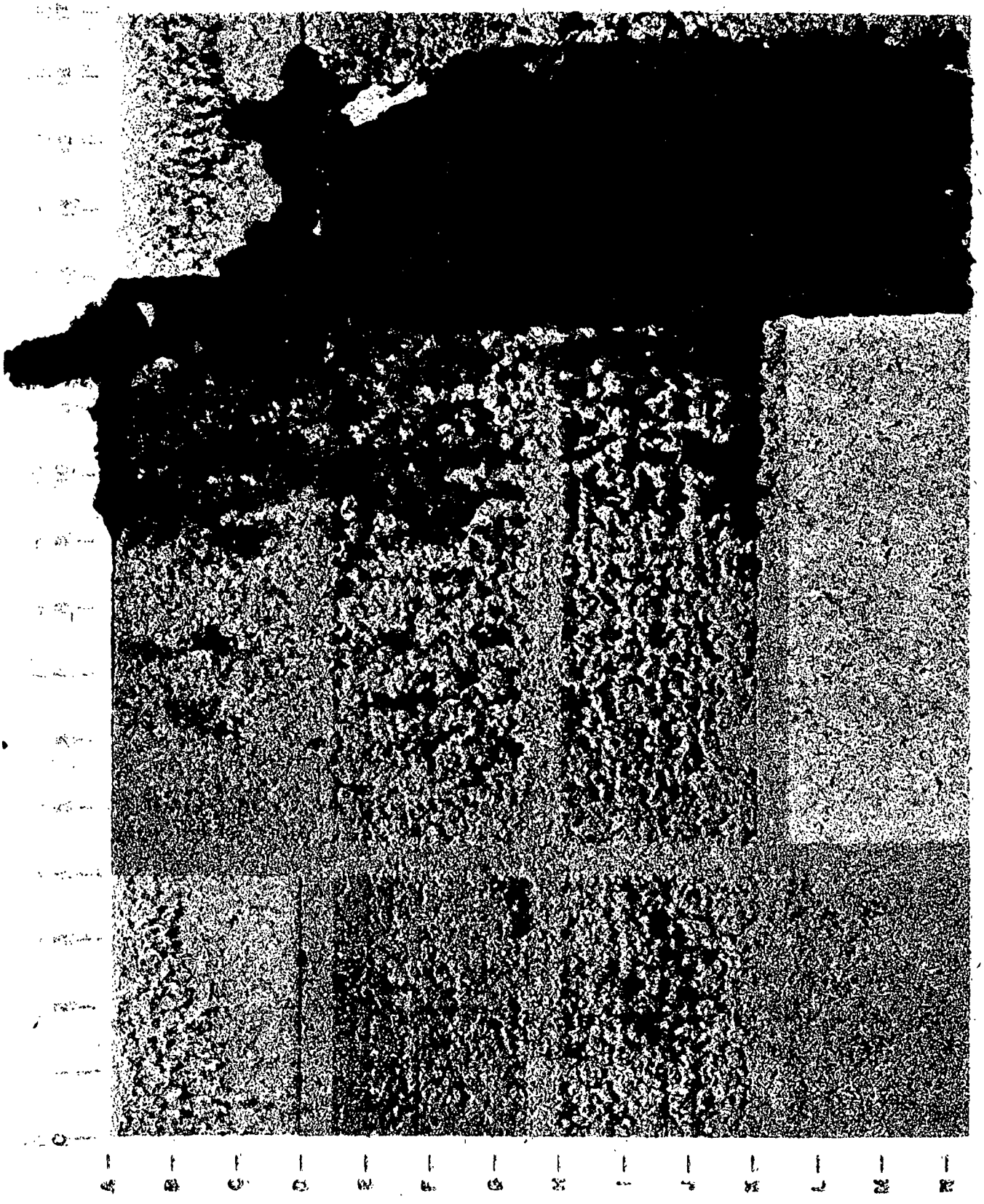
APPENDIX II

SELECTED PHOTOGRAPHIC PRINTS SHOWING BLANKET LINT DISTRIBUTION

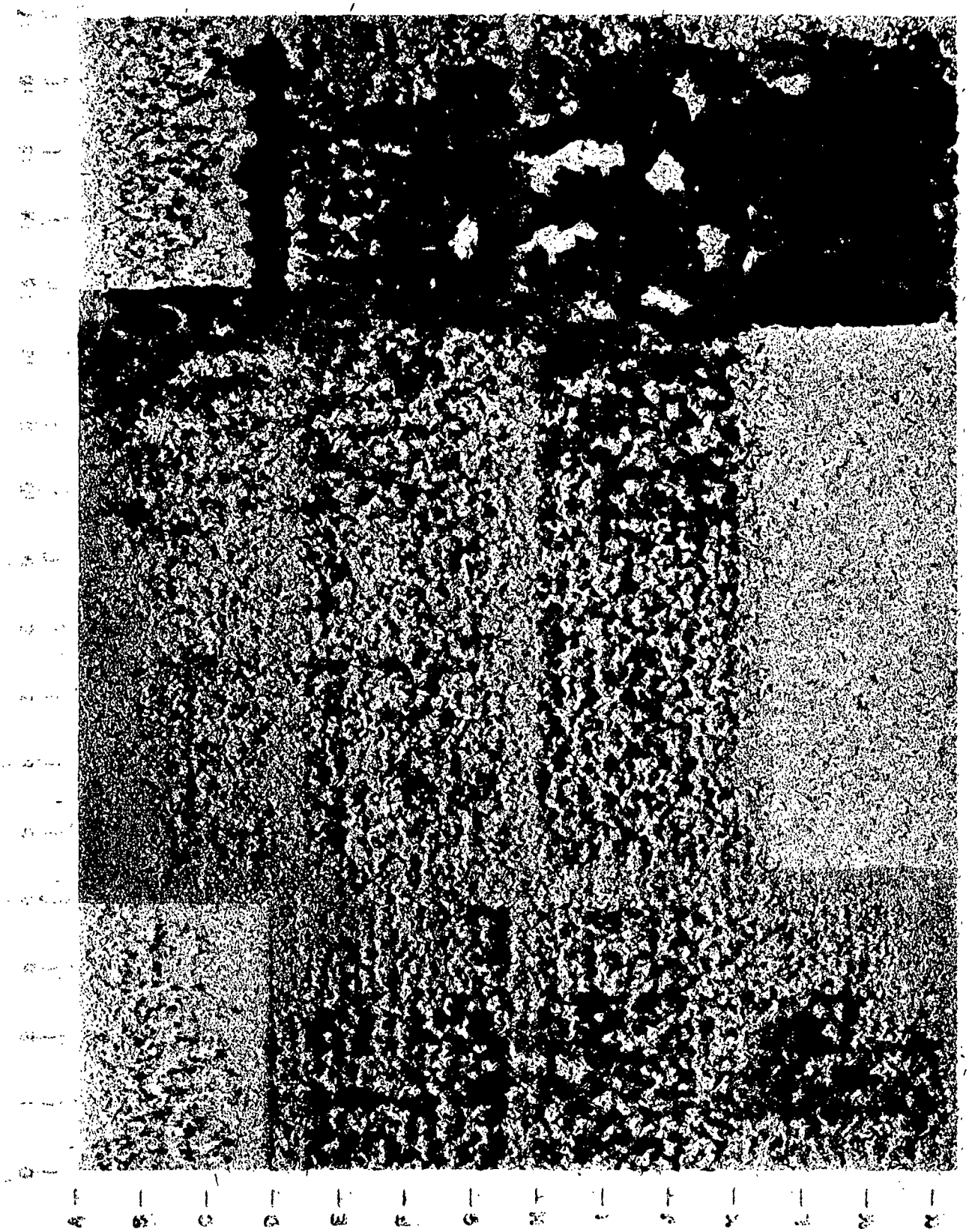
Runs 21 and 38 on paper Surface Q. These show evidence of loss of lint from the blanket and replication was poor.

Runs 18 and 31 on paper Surface S. These show evidence of loss of lint from the blanket and replication was poor.

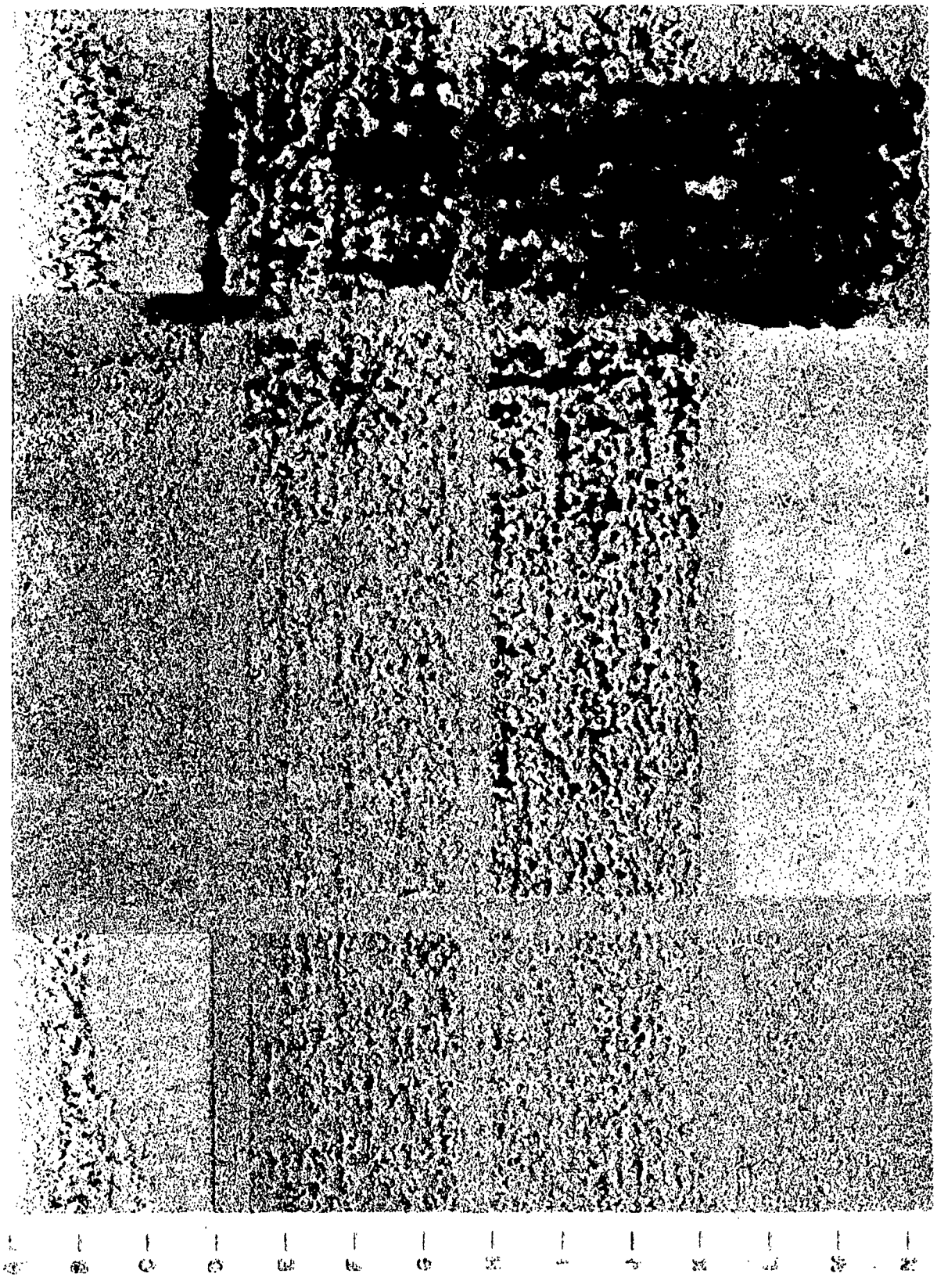
Runs 1 and 37 on paper Surface A. These show no evidence of loss of blanket lint and the replication was satisfactory.



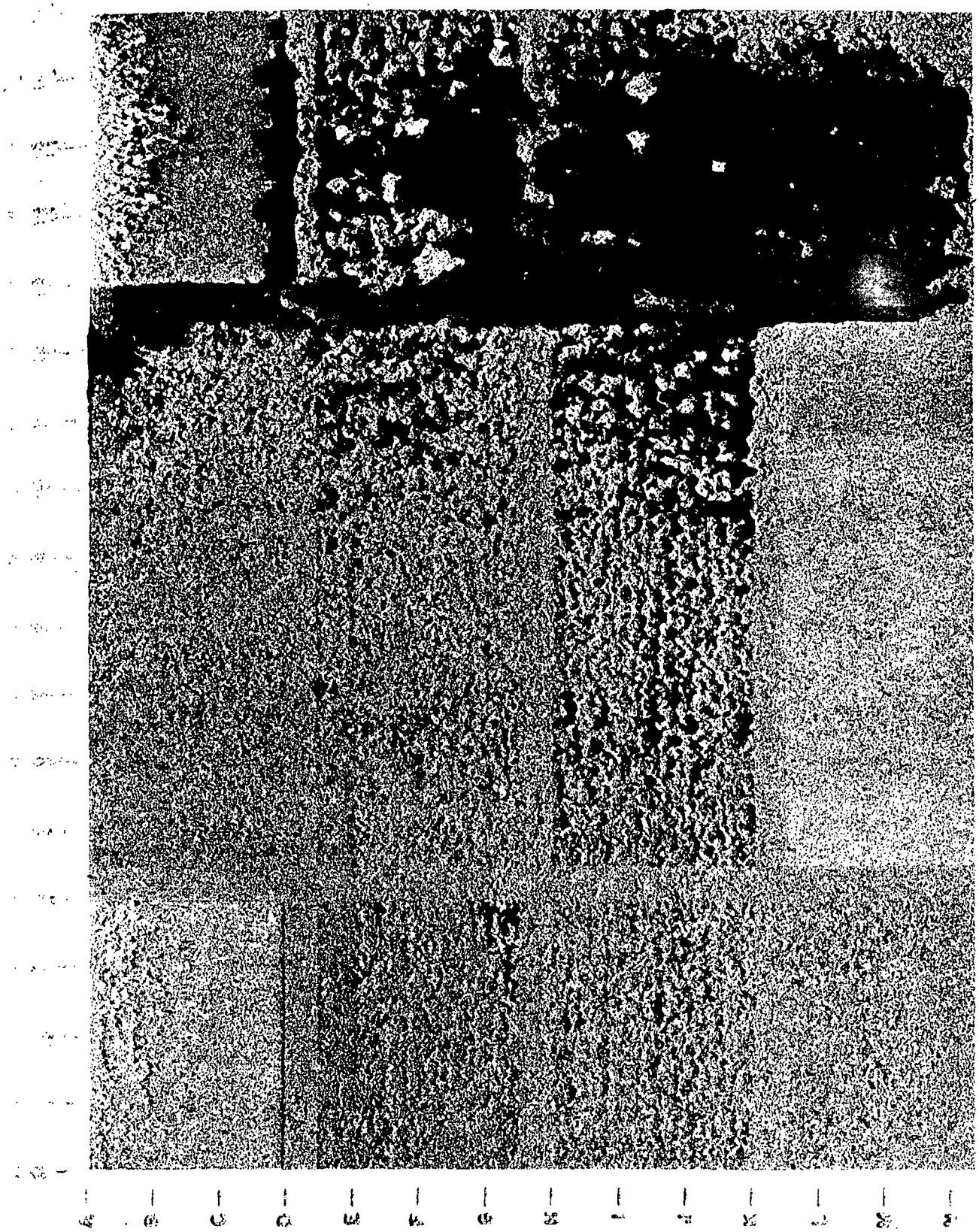
Blanket Lint Distribution
Run 21, Paper Surface Q



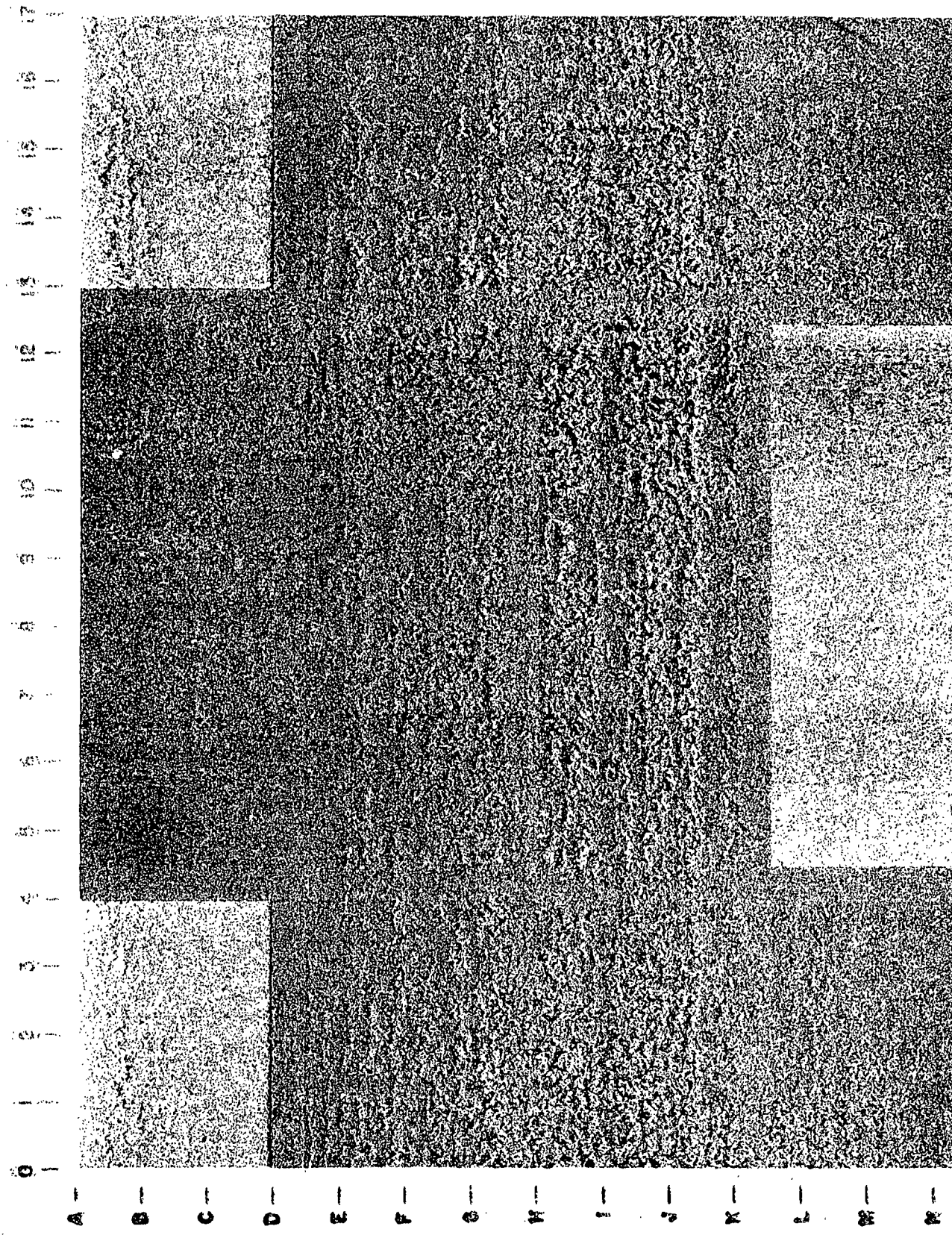
Run 38, Paper Surface Q



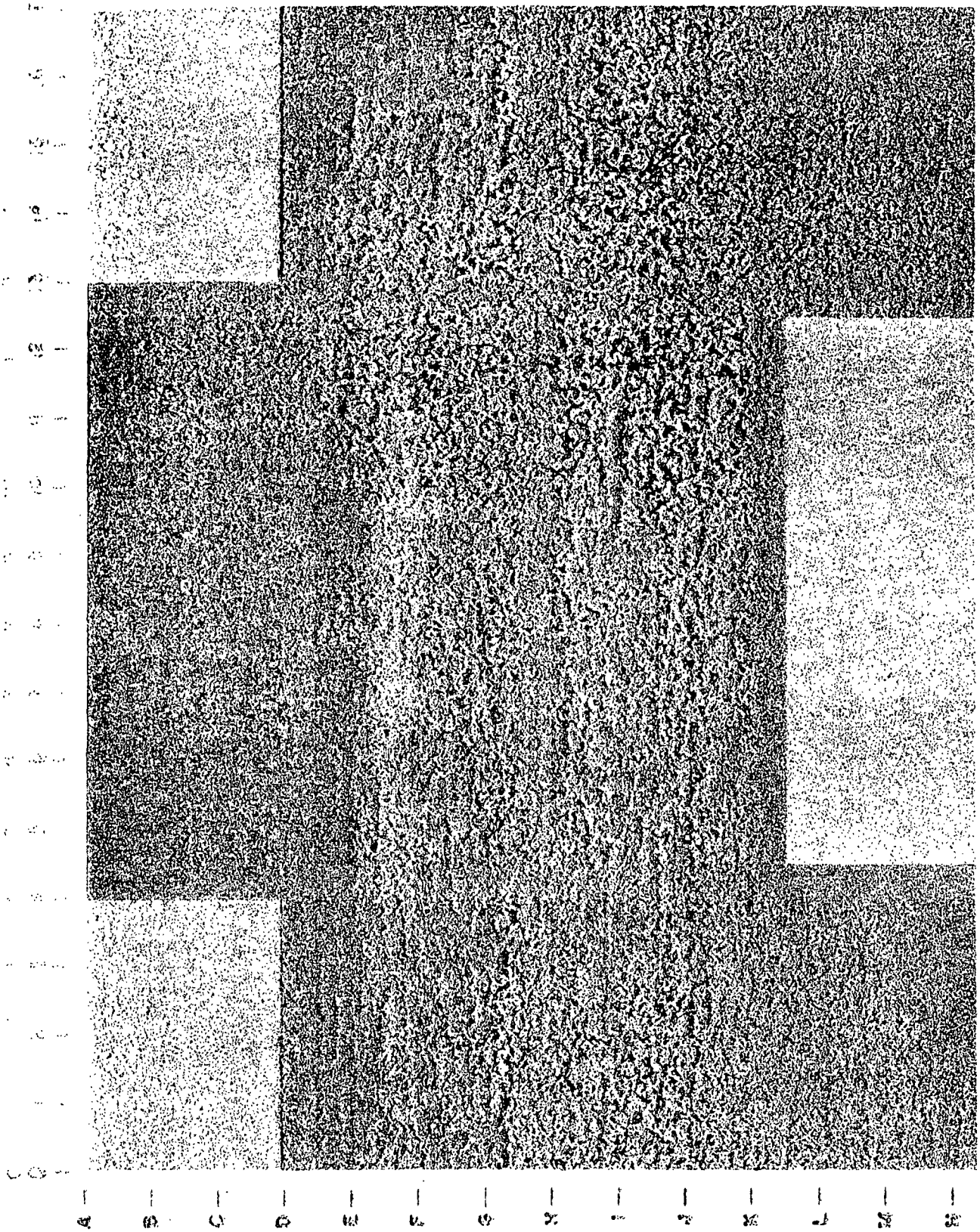
Blanket Lint Distribution
Run 18, Paper Surface S



Blanket Lint Distribution
Run 31, Paper Surface S



Blanket Lint Distribution
Run 1, Paper Surface A

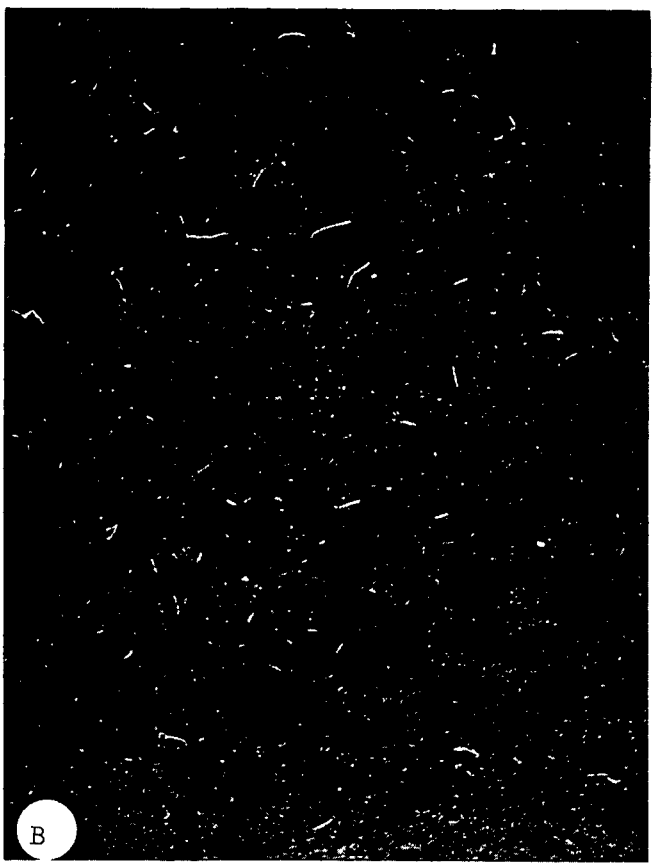


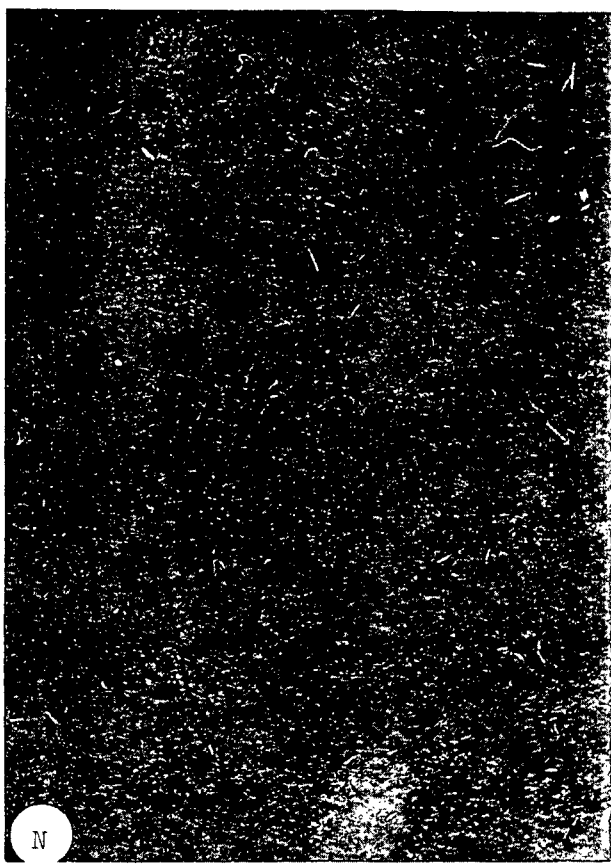
Blanket Lint Distribution
Run 37, Paper Surface A

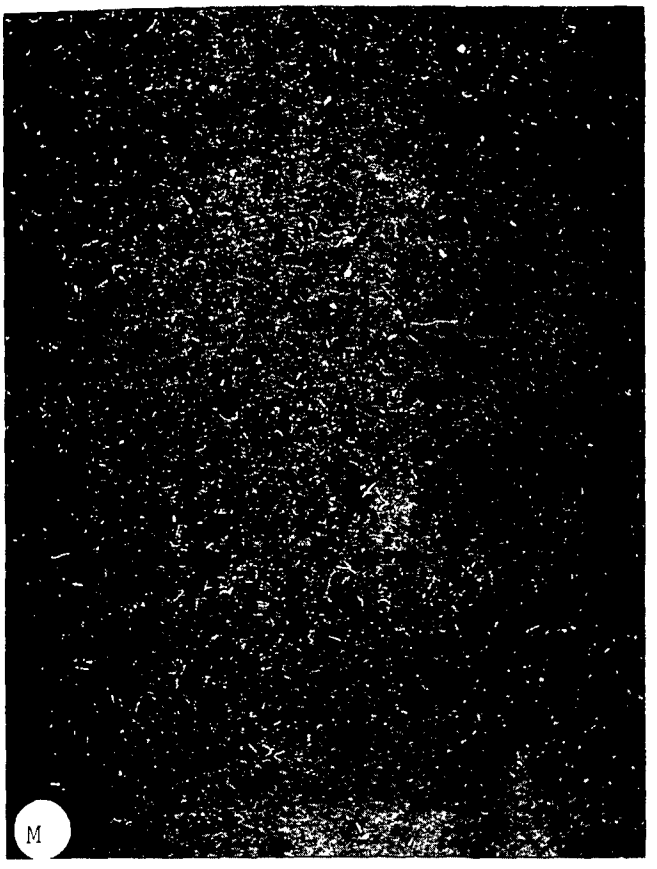
APPENDIX III

PHOTOGRAPHS OF IGT LINT ON THE BLACK FILTER PAPERS

Identified by letter code of paper surface and arranged in order of increasing lint as ranked by viewing the full filter containing the lint (not by rank of the photographs).



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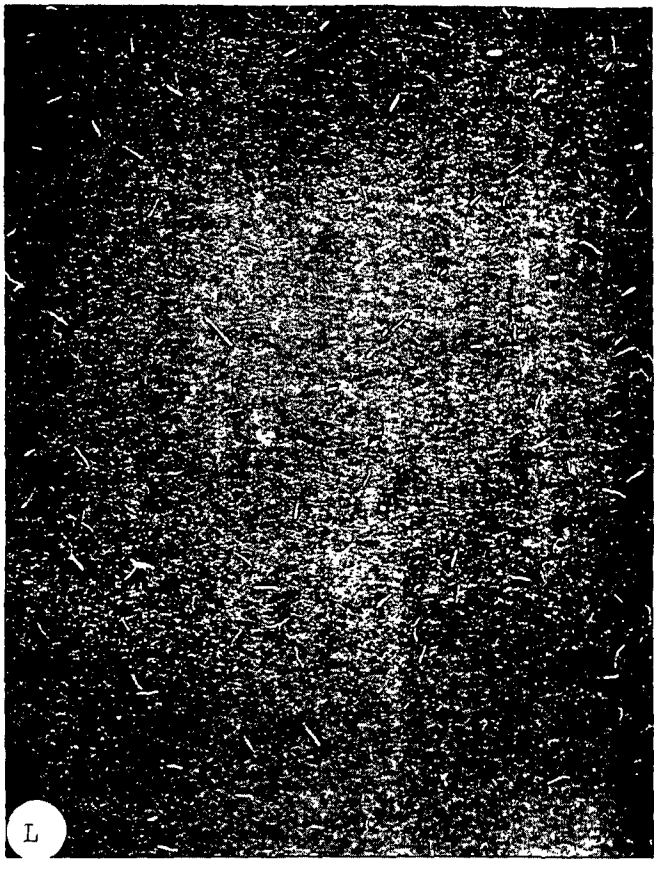
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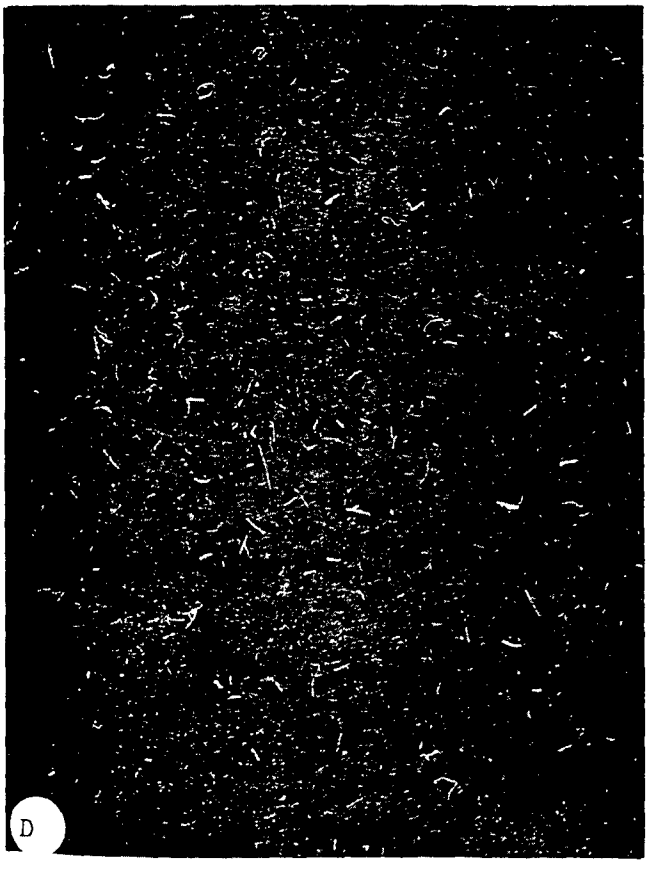
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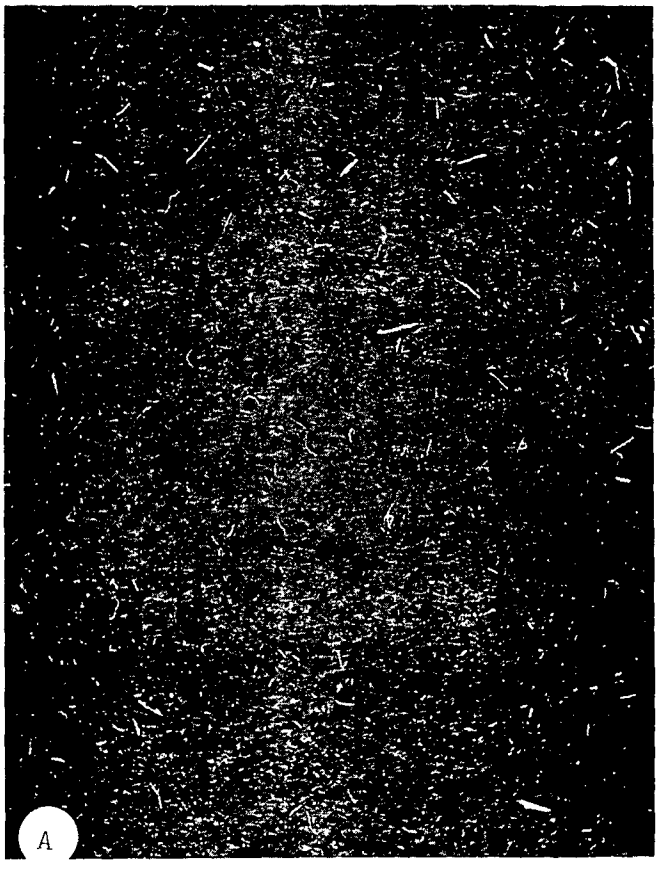
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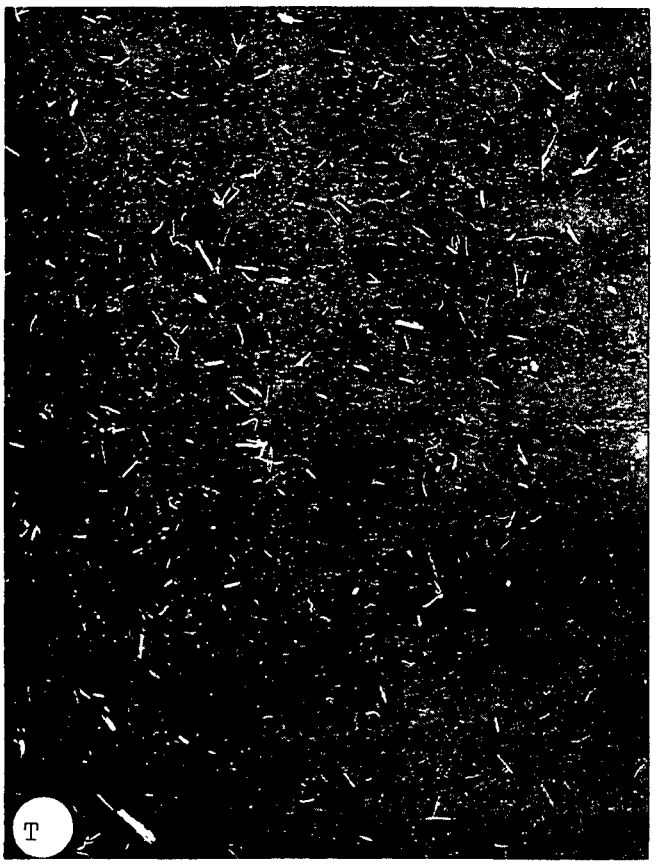
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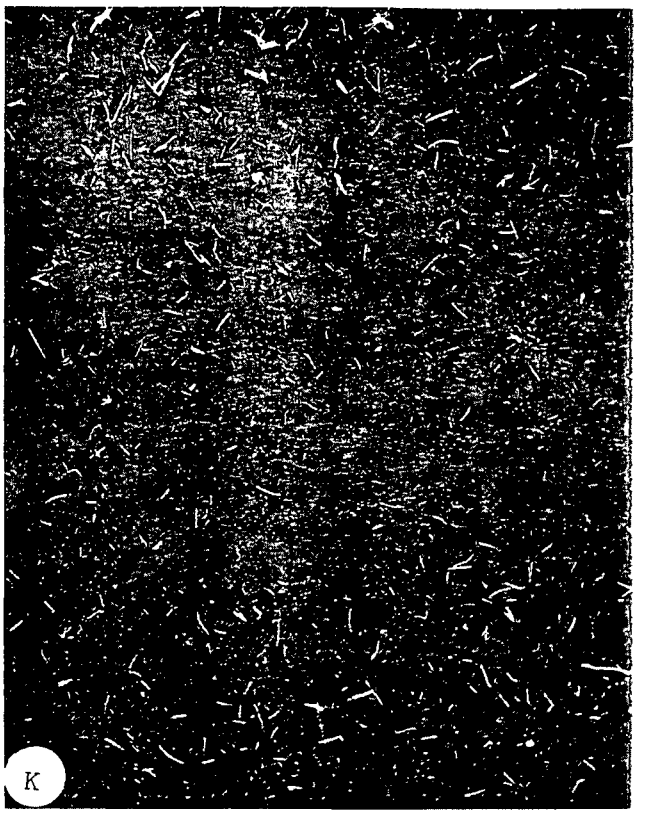
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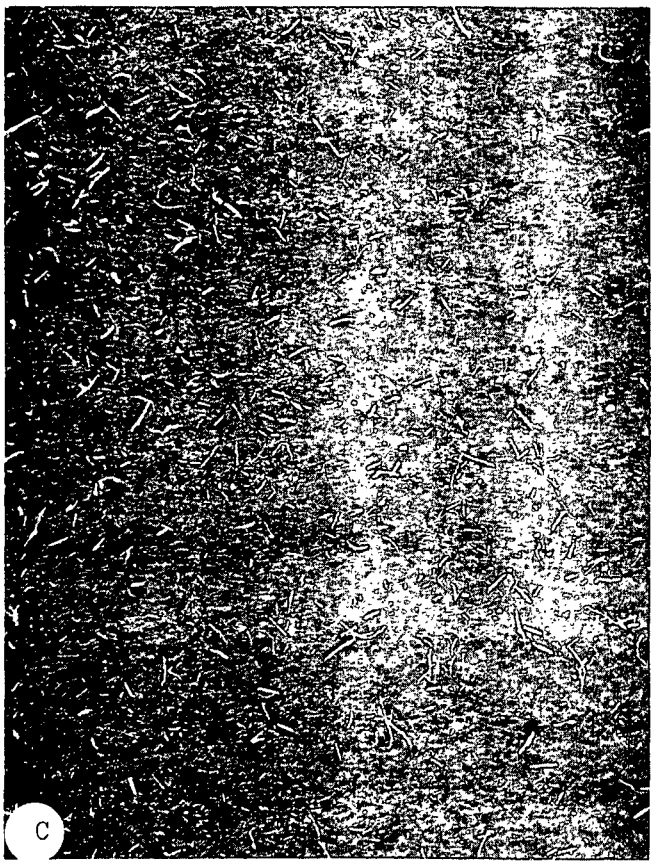
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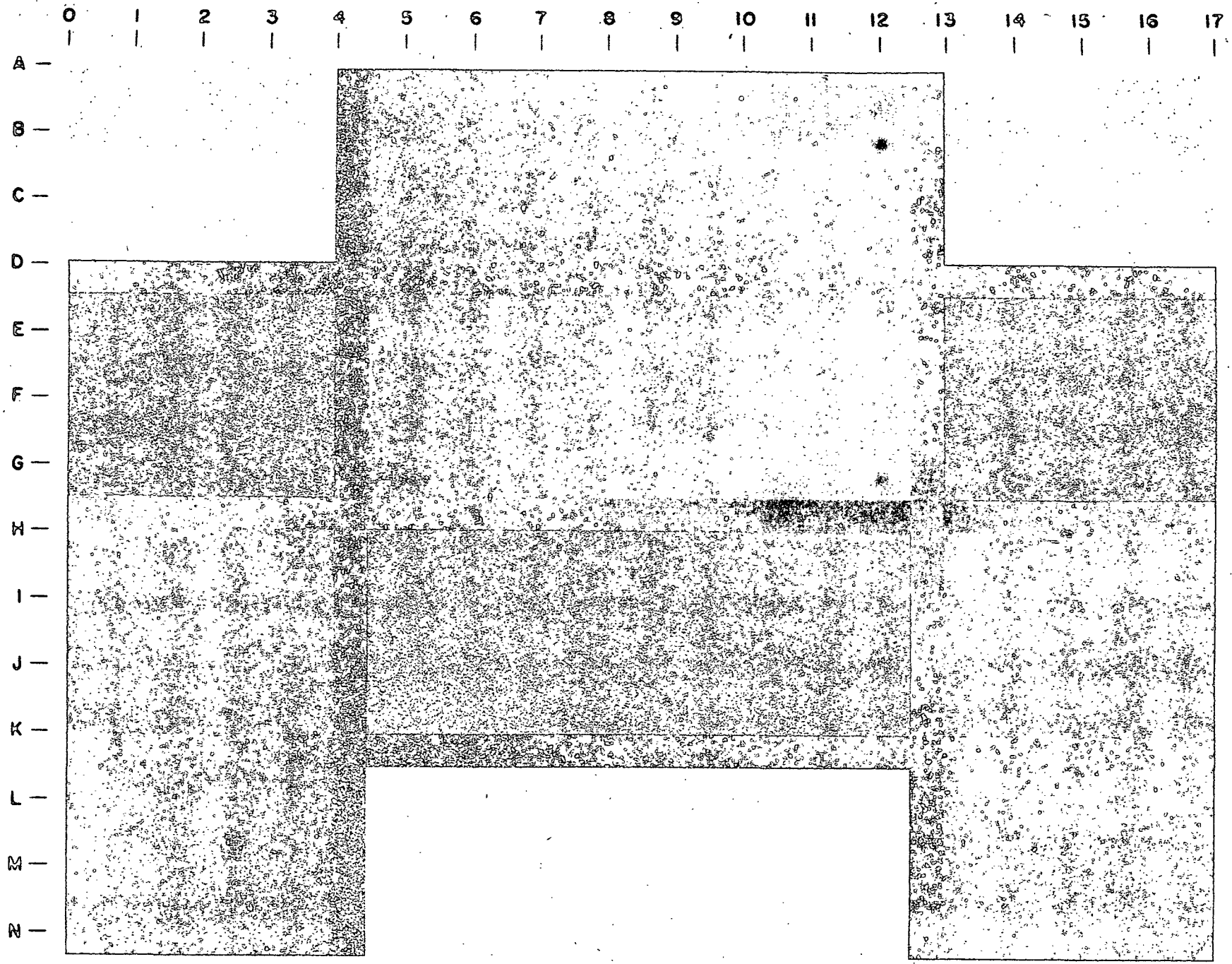
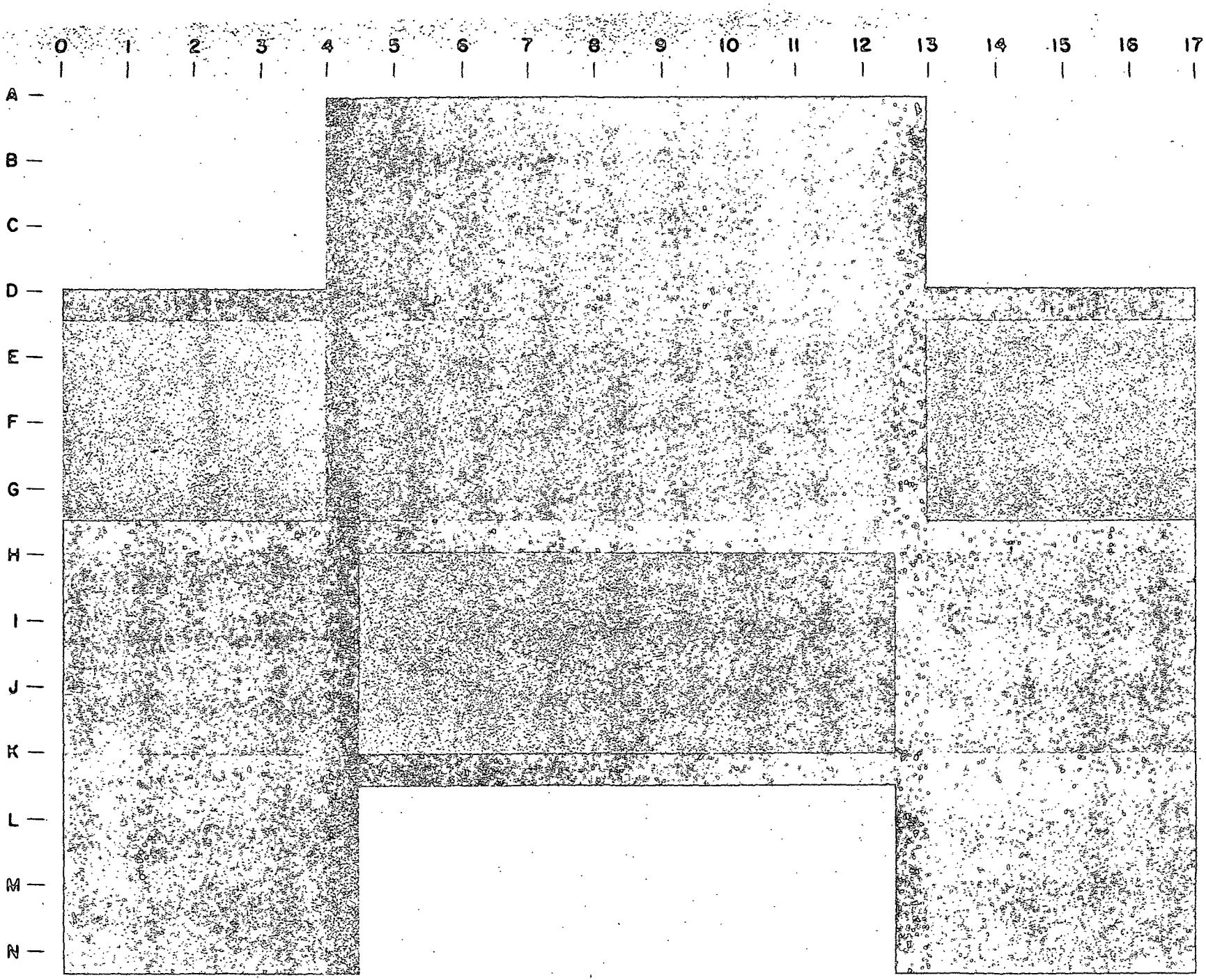
APPENDIX IV

END-OF-RUN PRINTS FROM APOLLO PRESS

End-of-run prints from the press runs identified by paper surface code and run number.



A-1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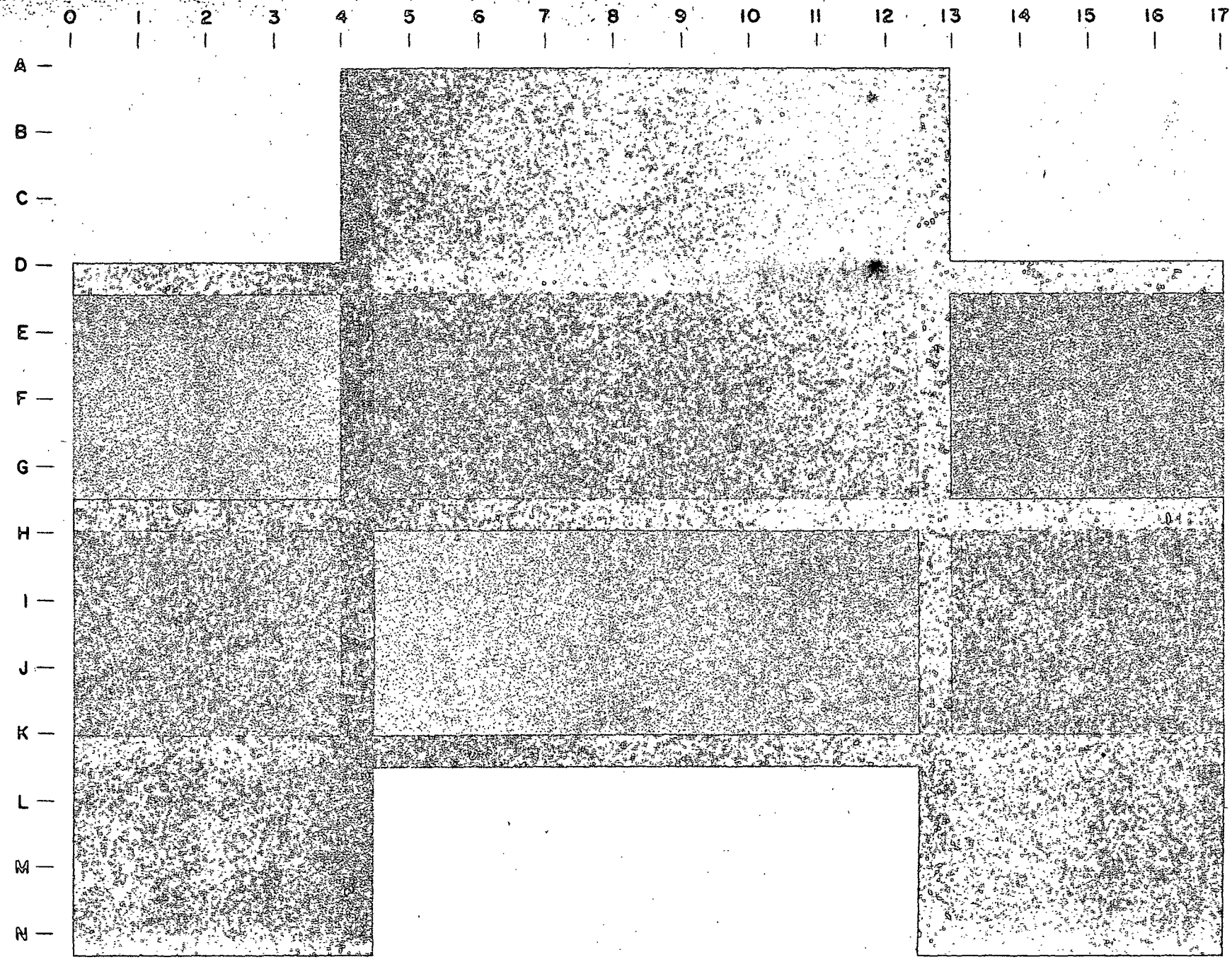
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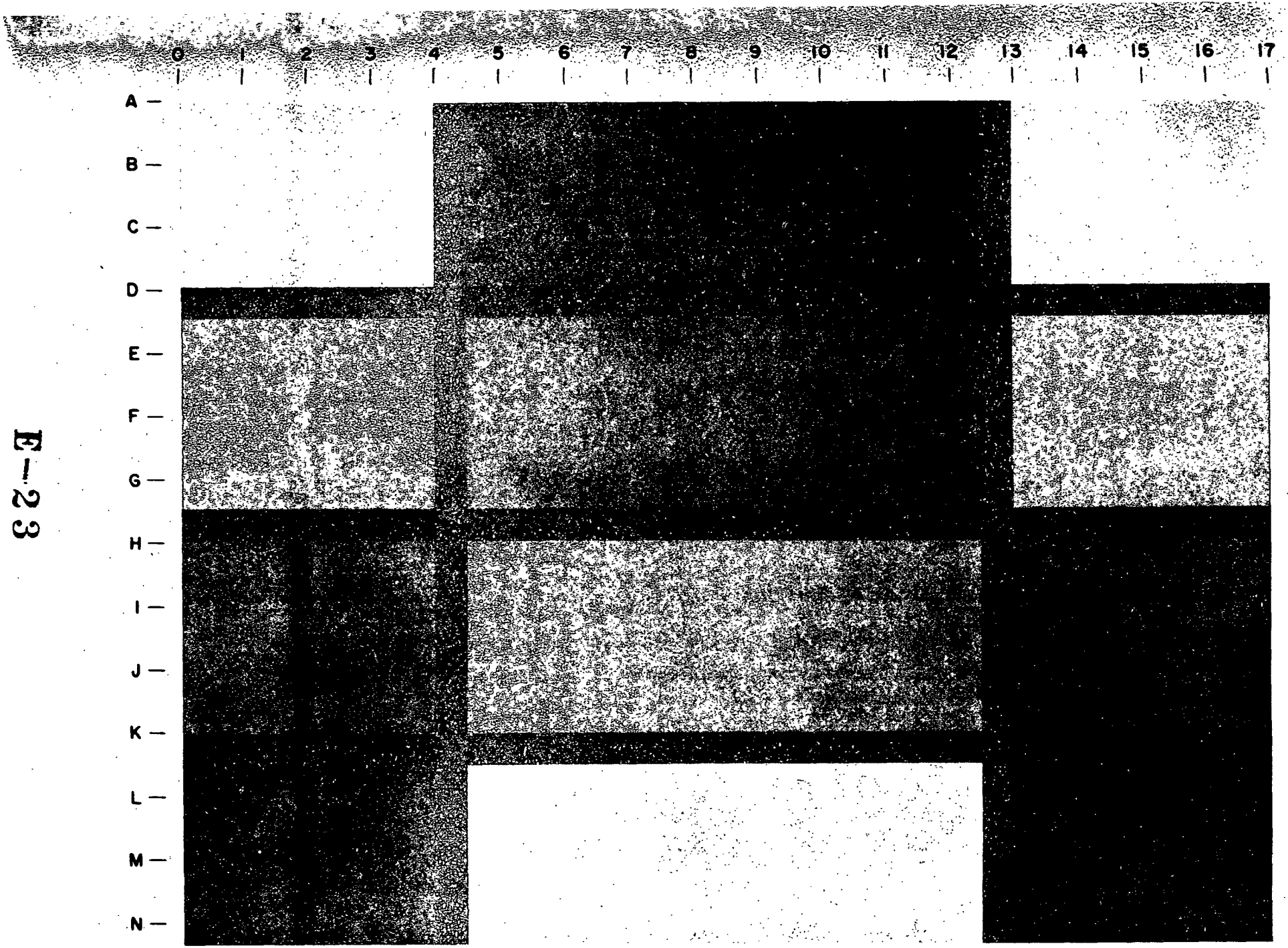
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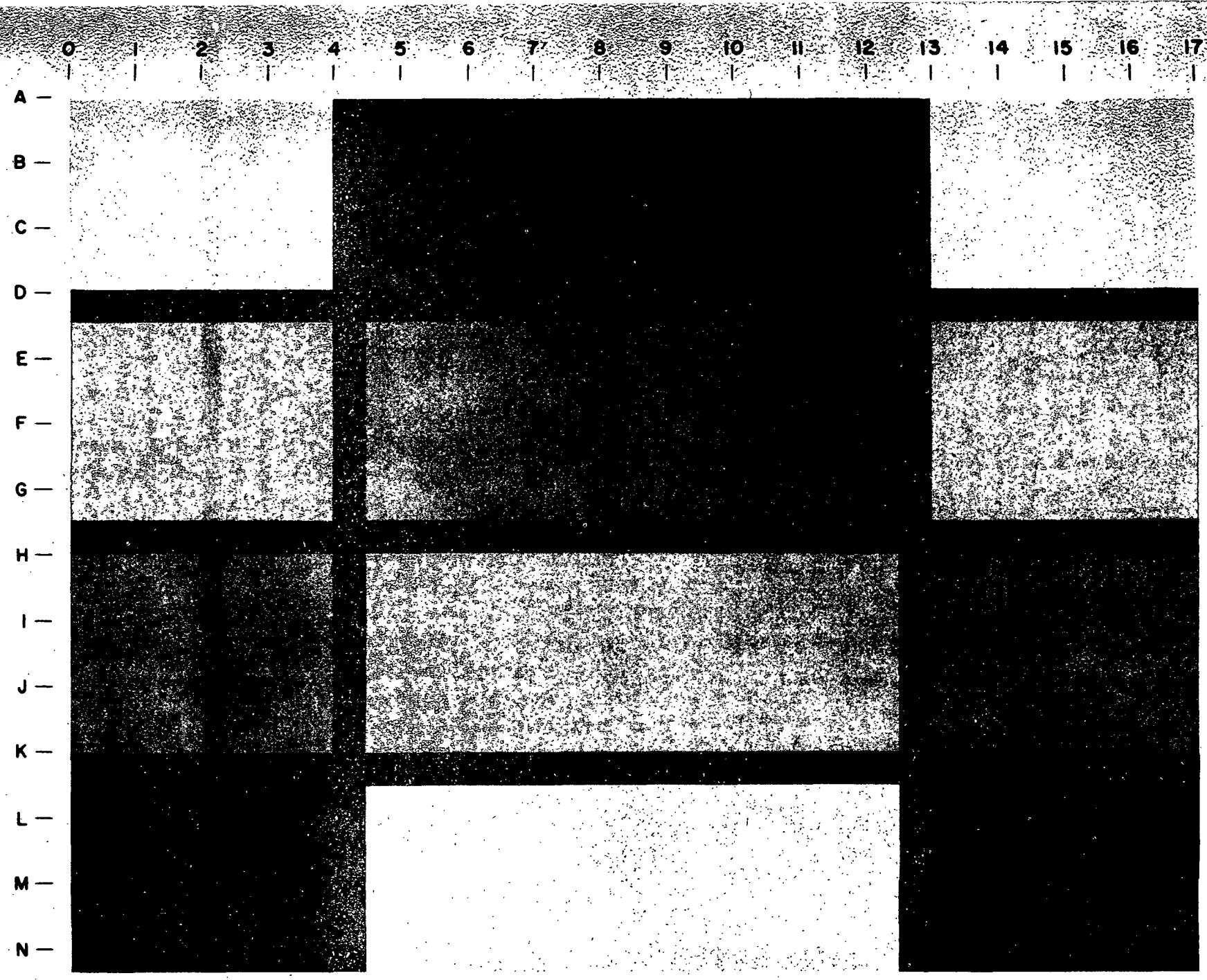
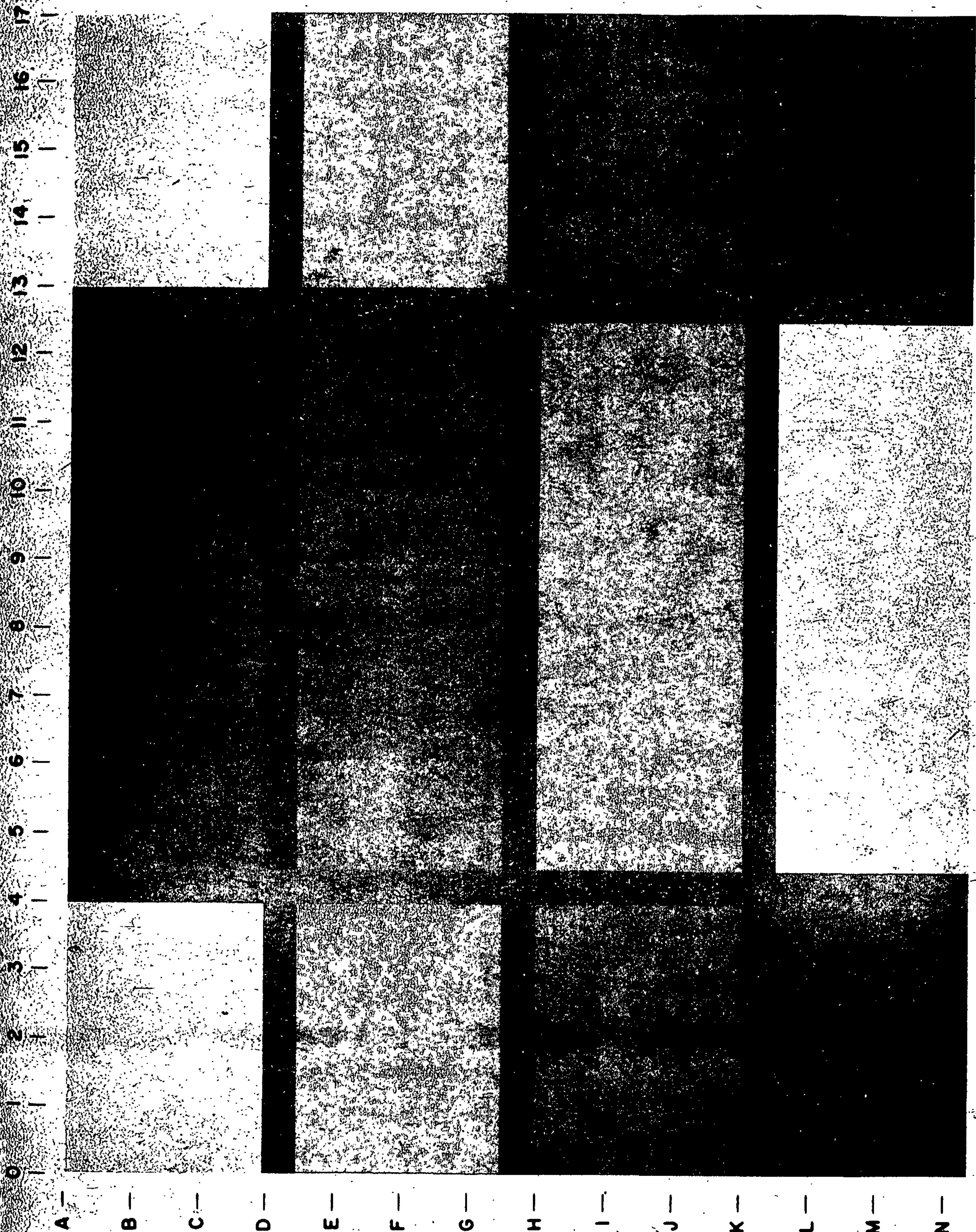


FIG 5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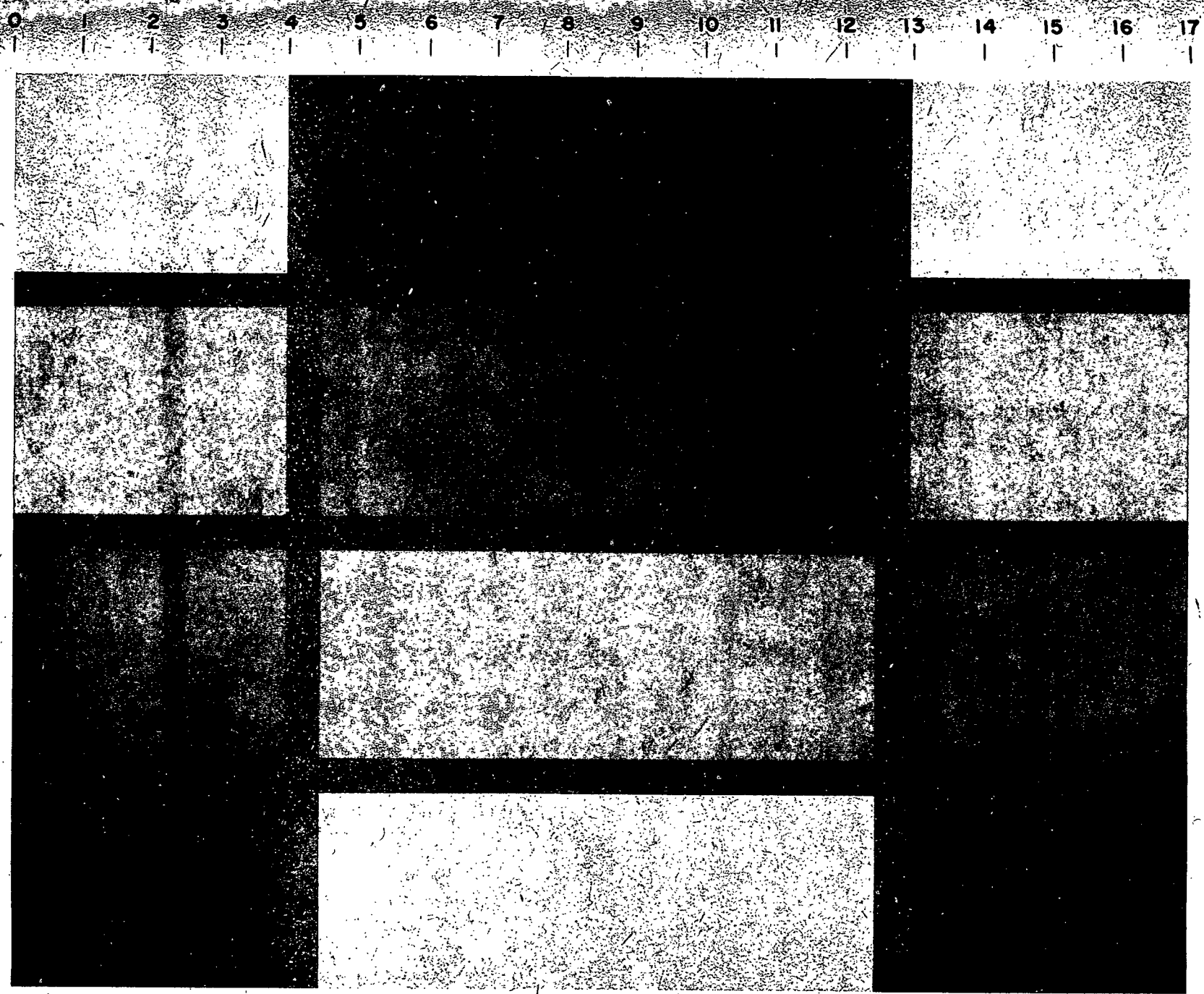
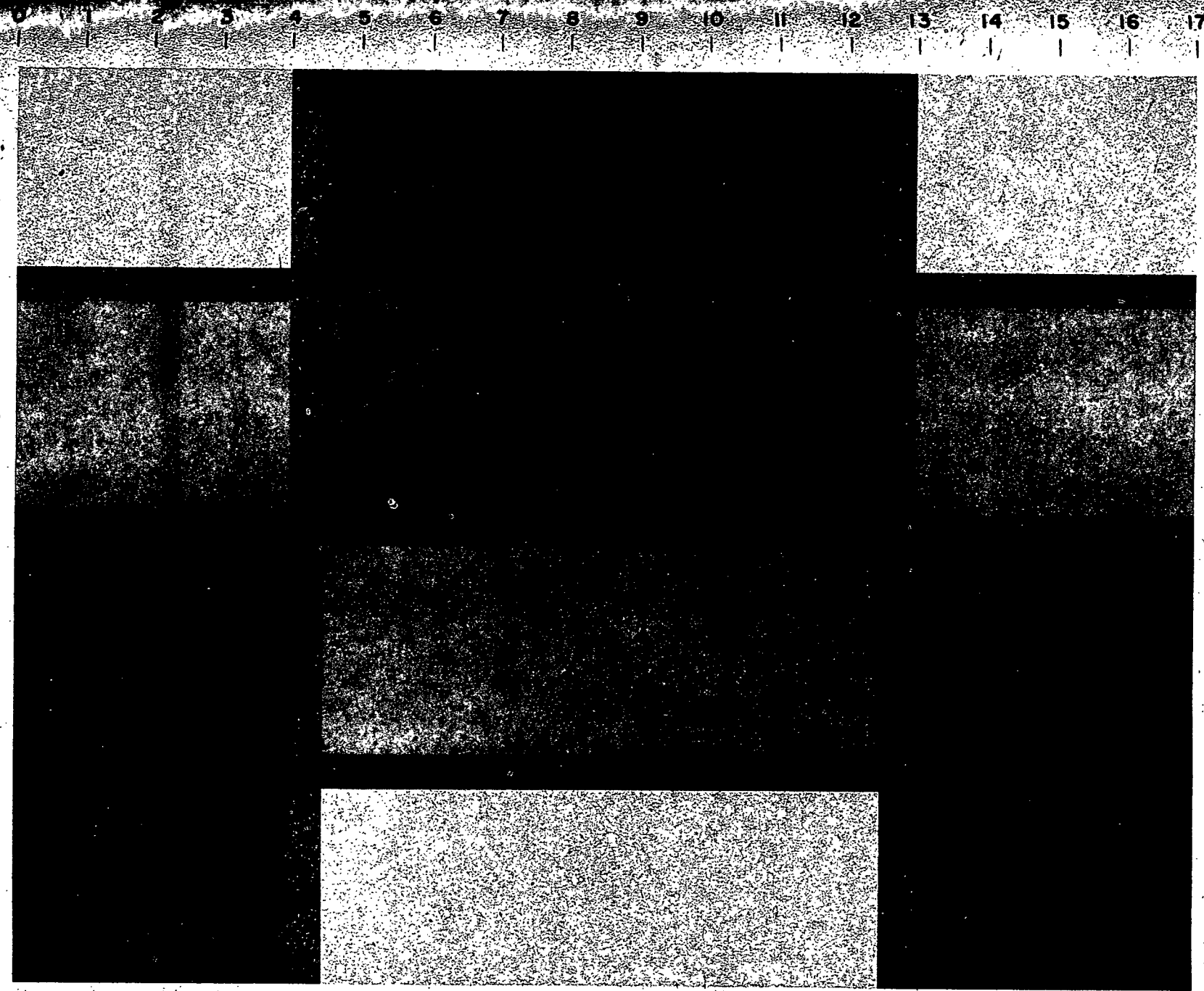


H-19



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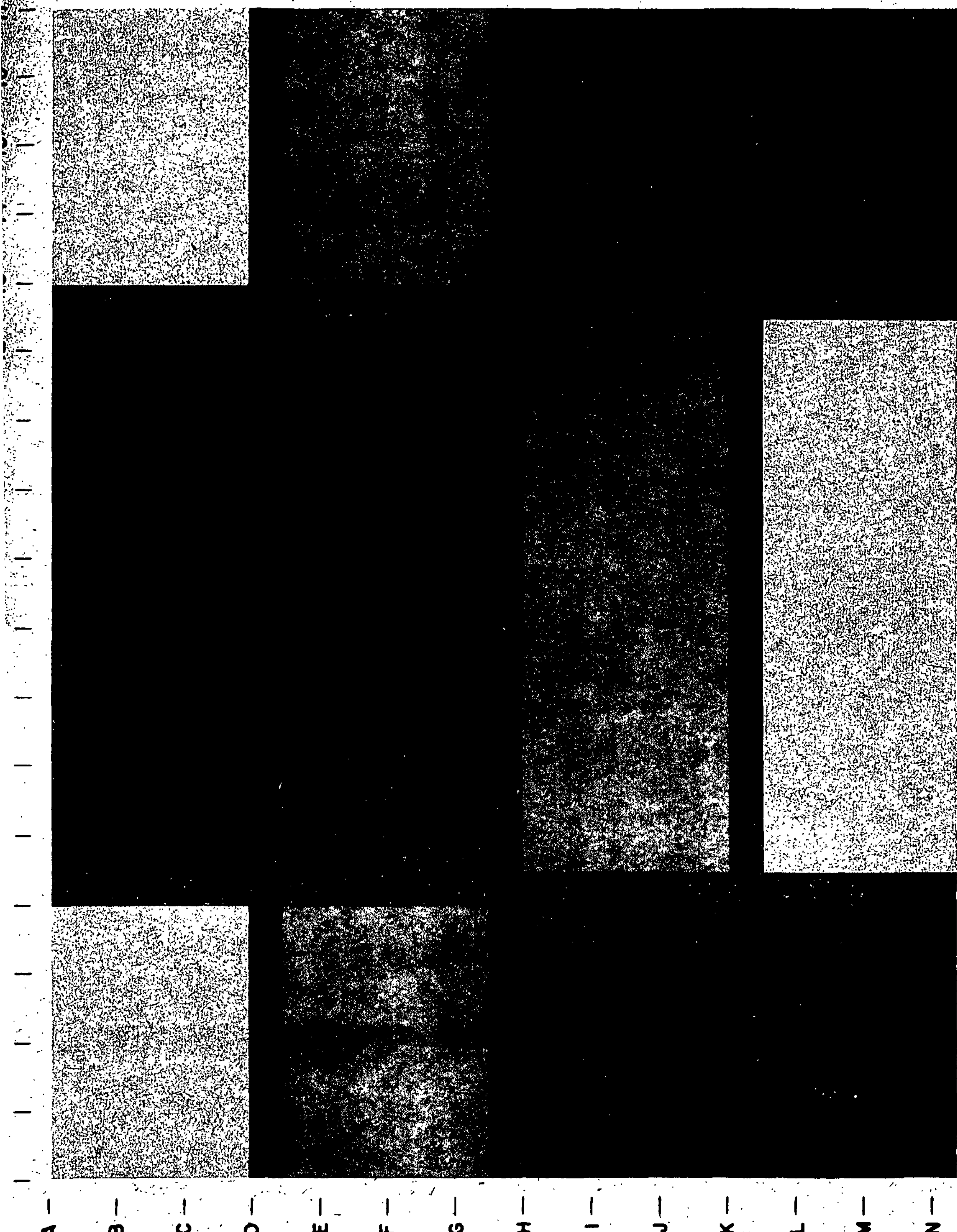
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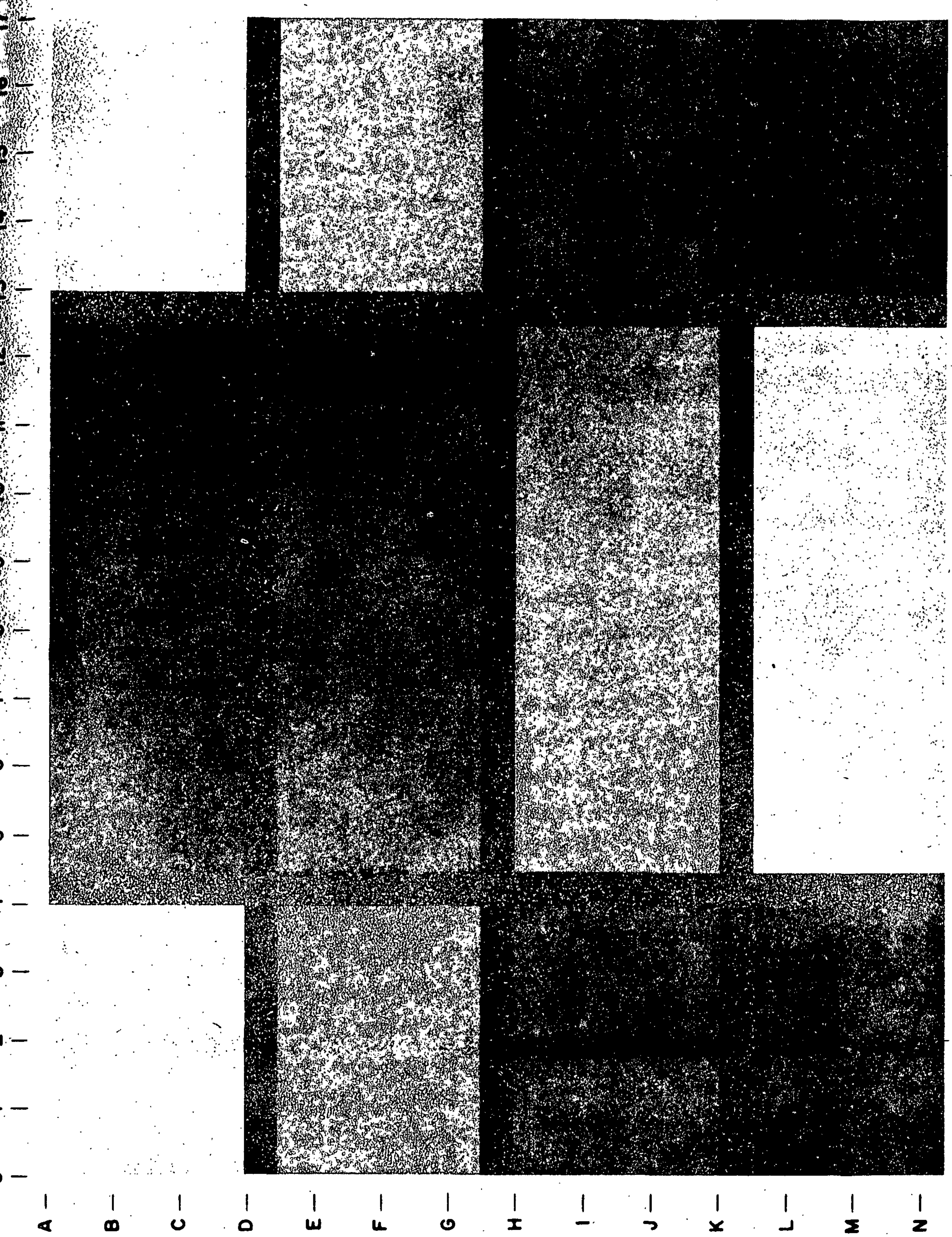
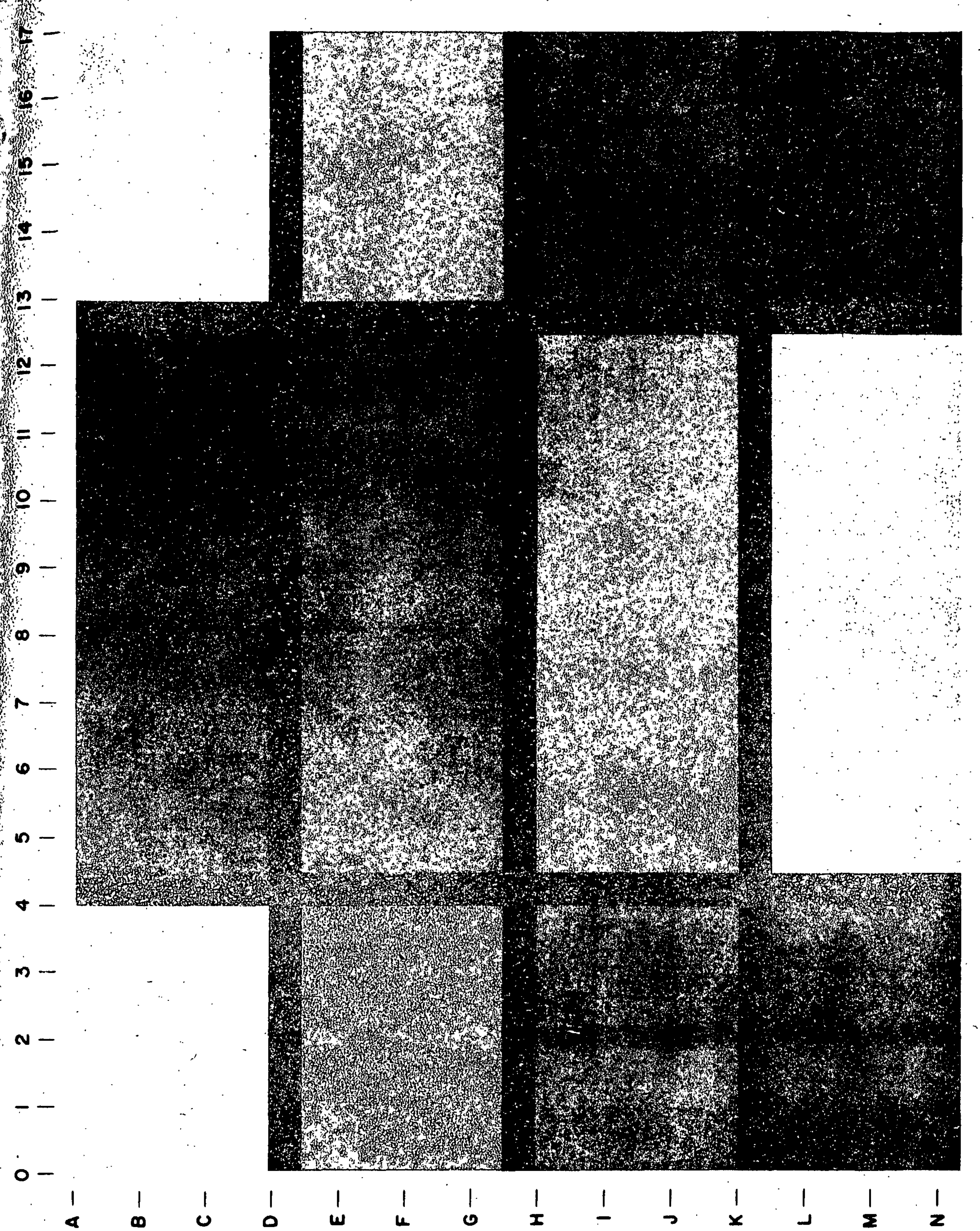


K-11



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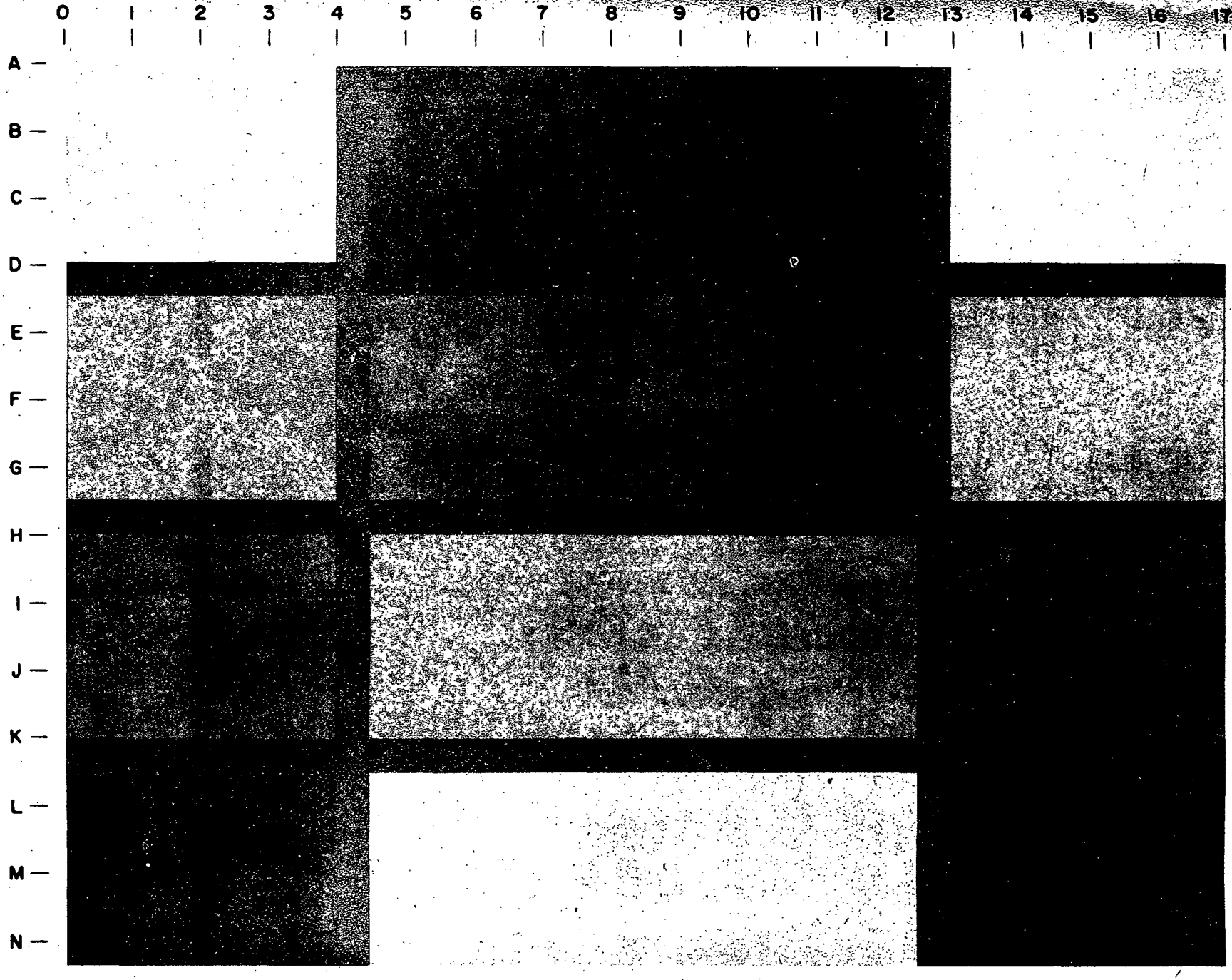
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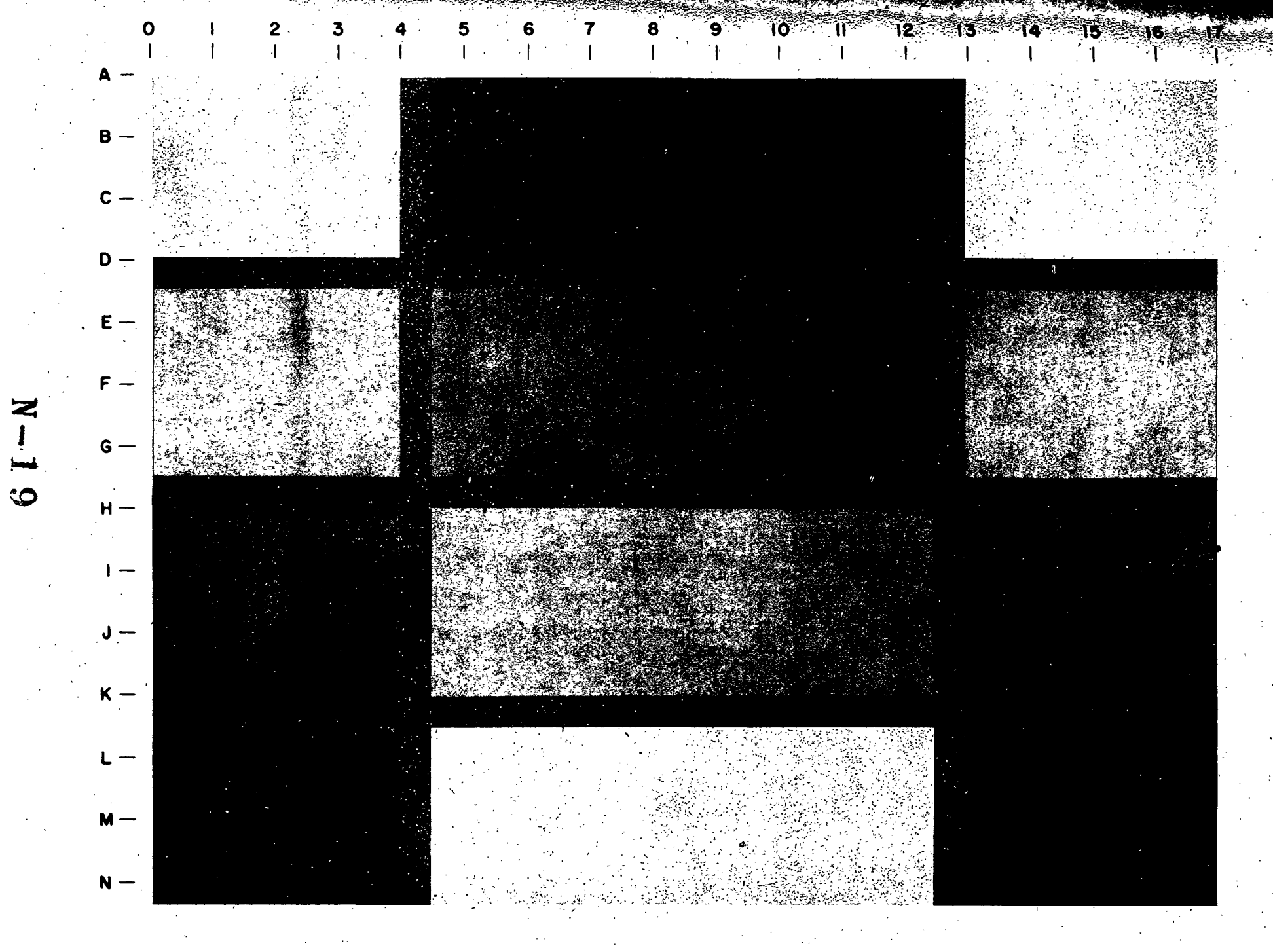
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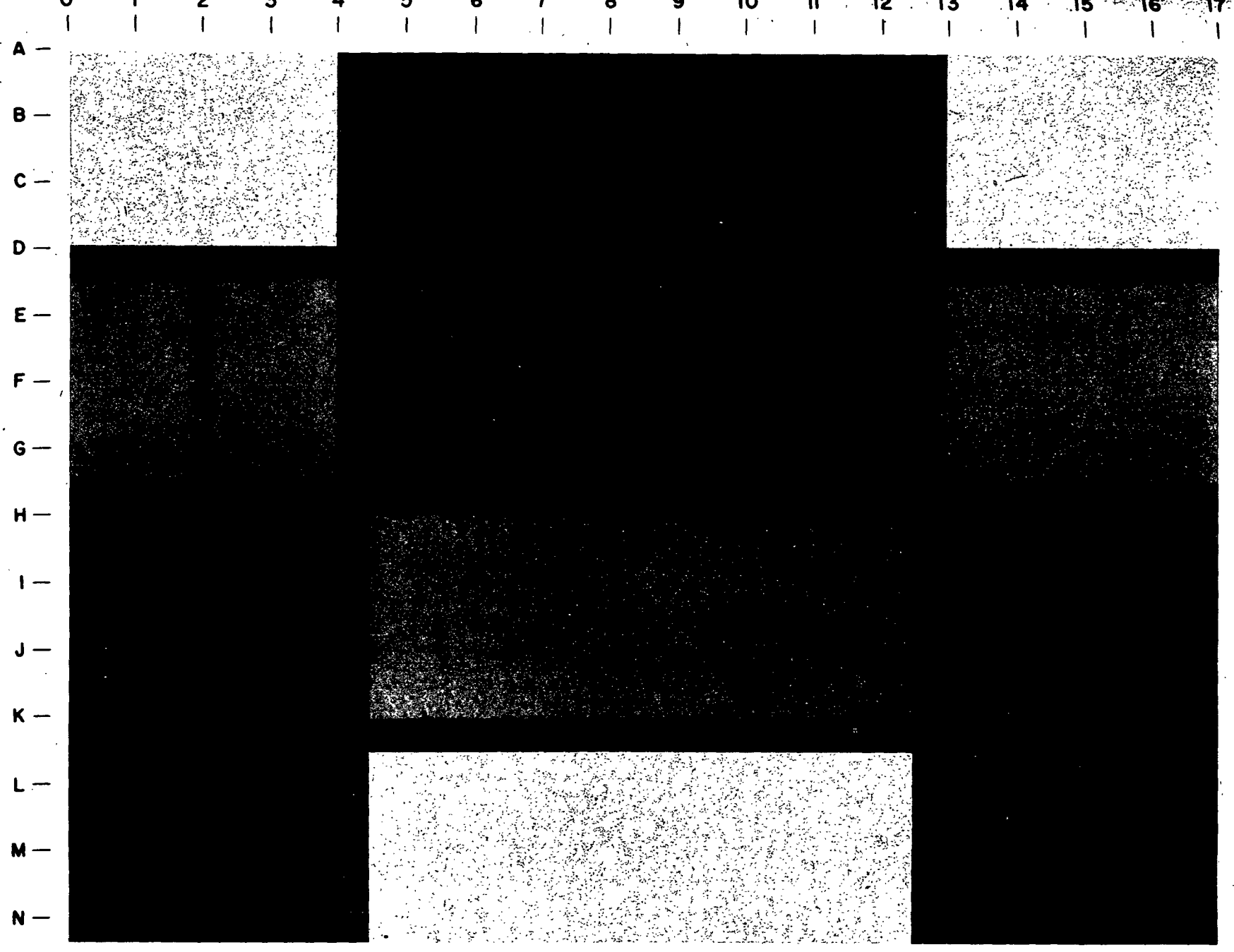
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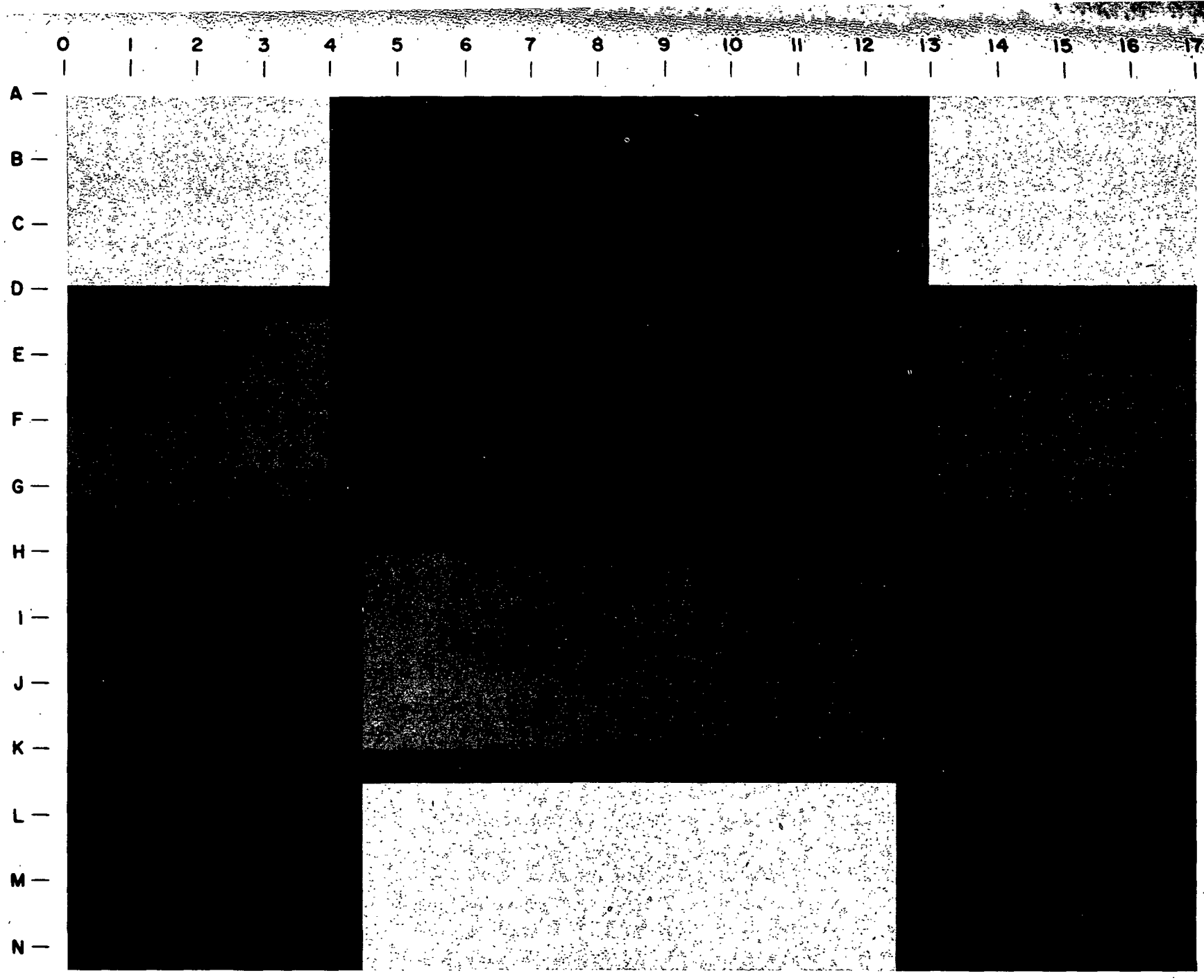
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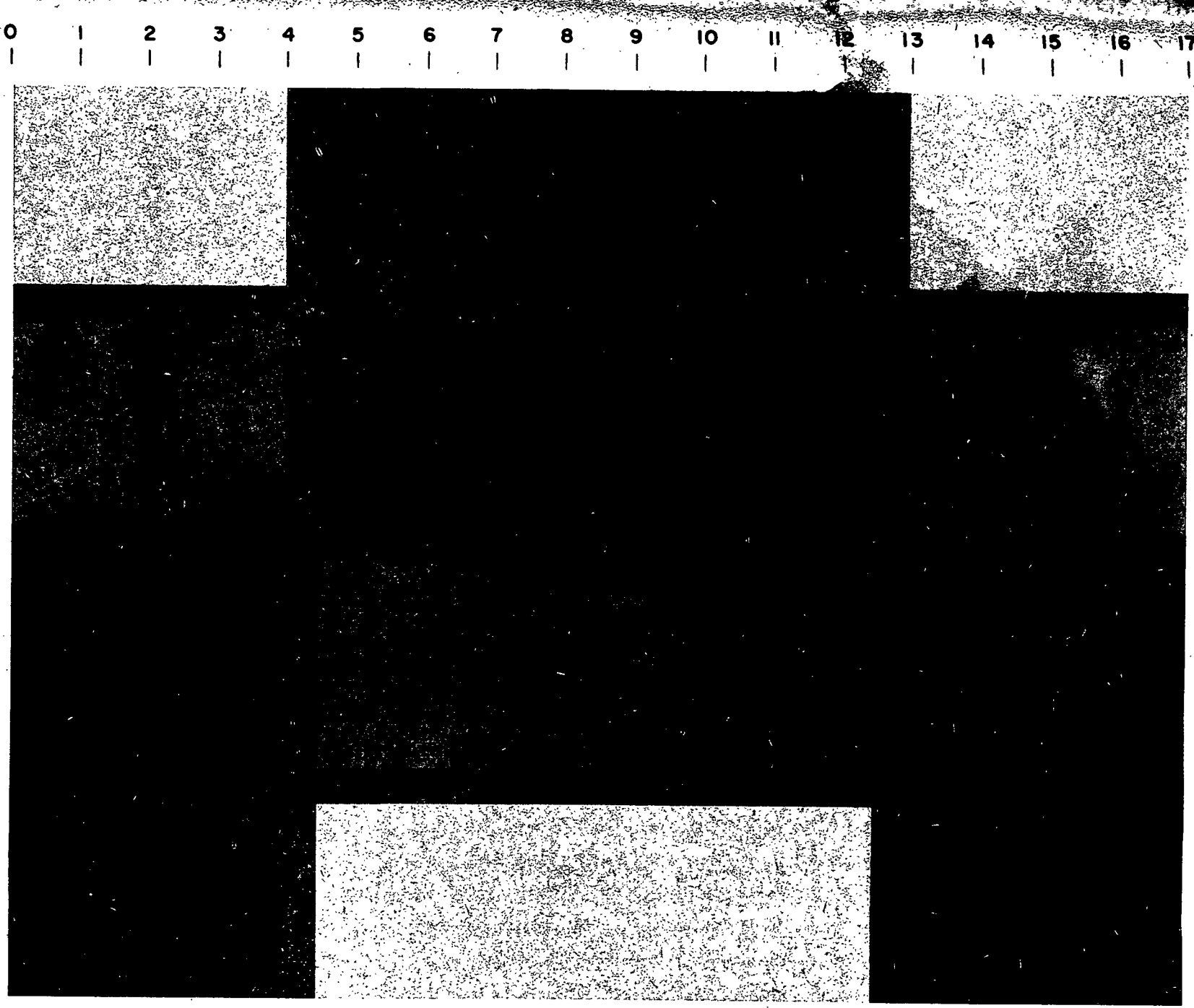
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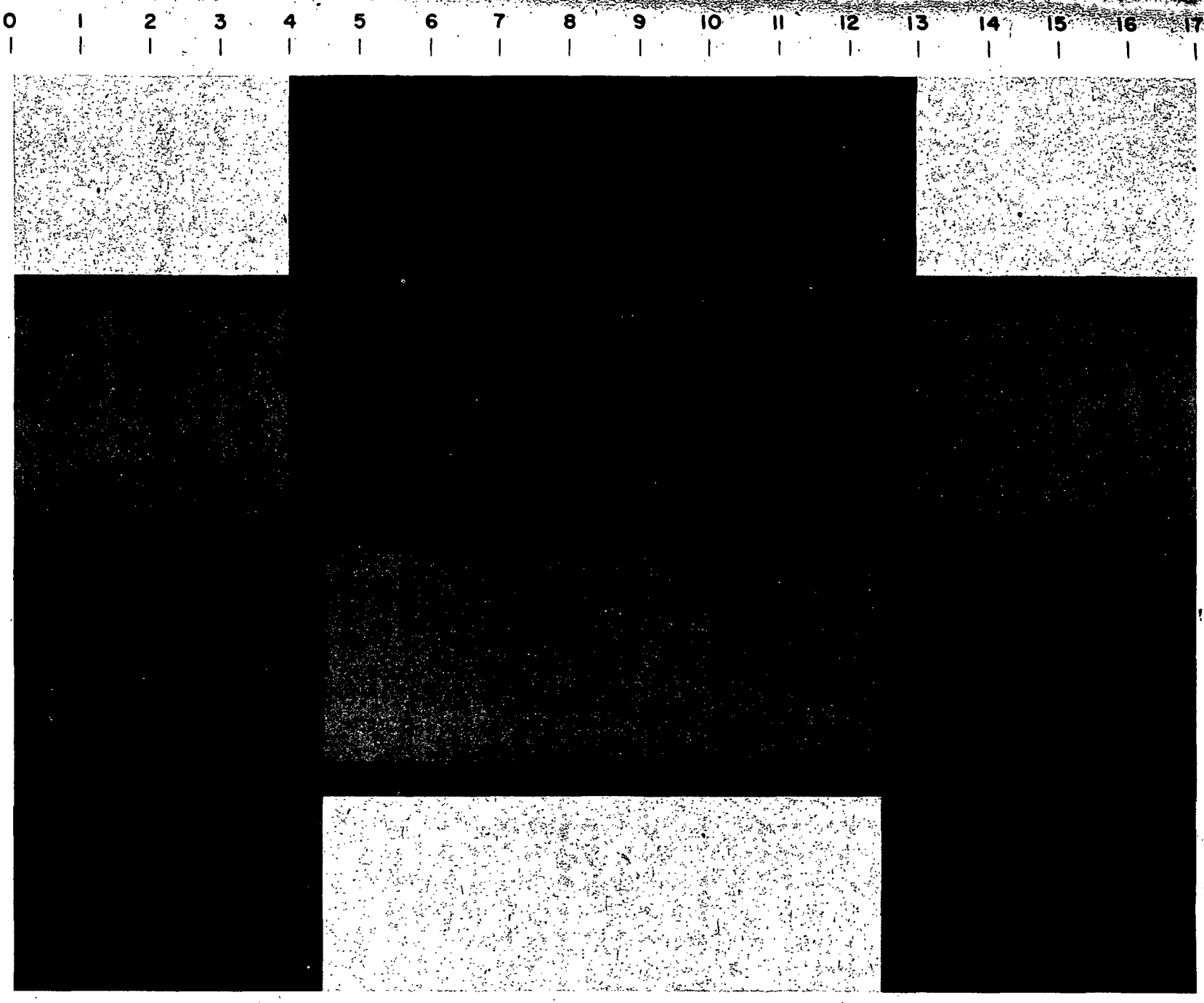
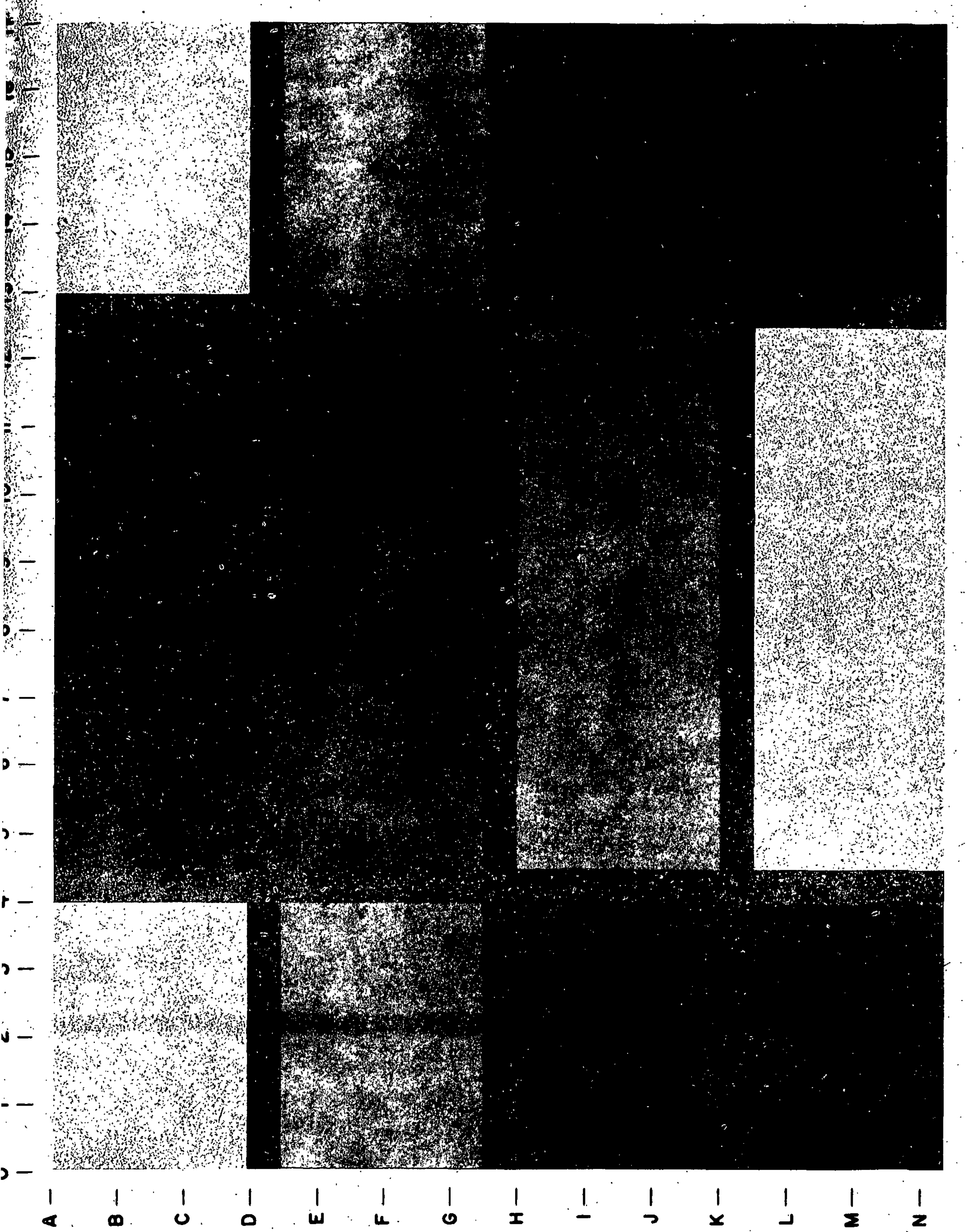


R-9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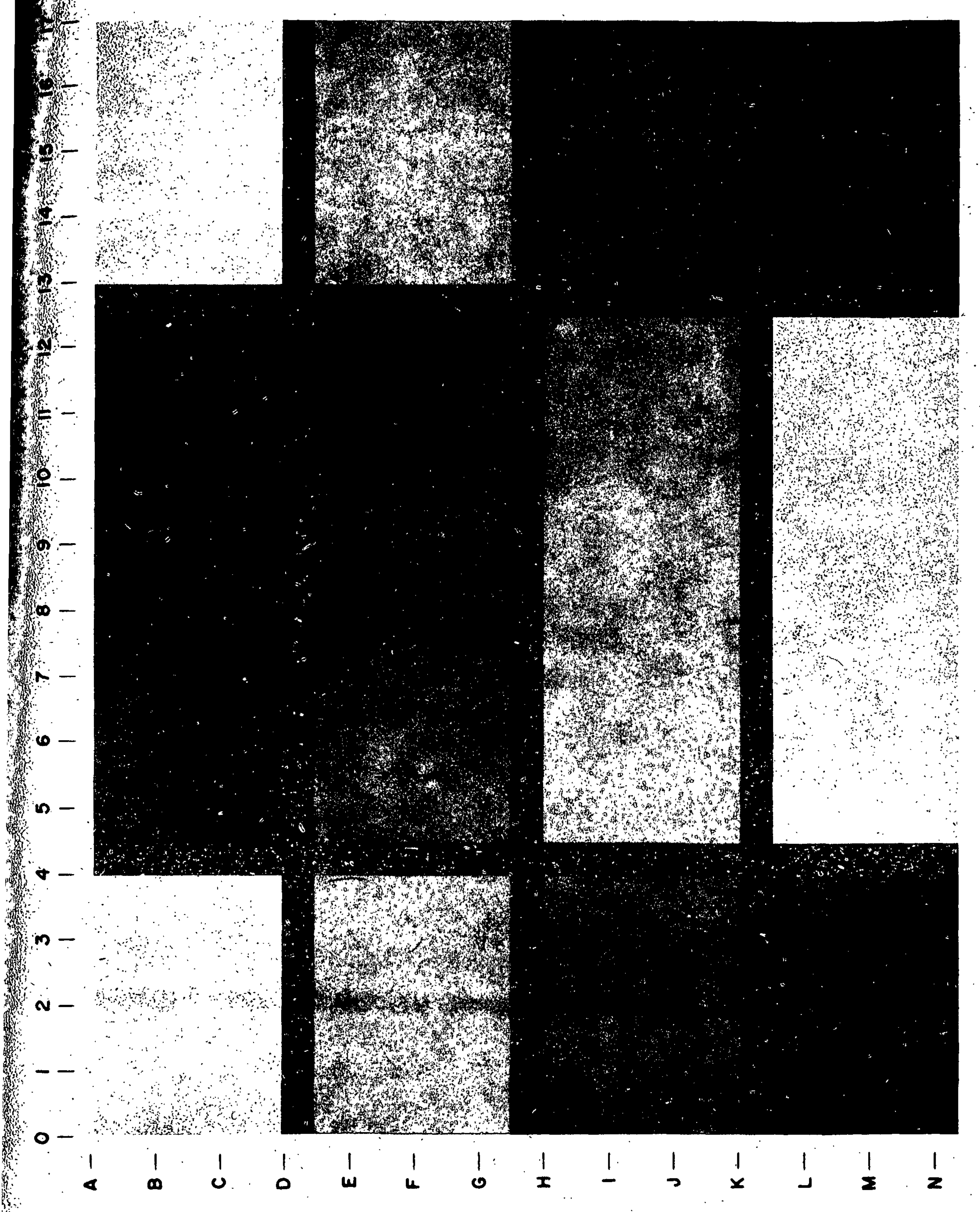

T-4